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BLOCKCHAINS AND DISTRIBUTED LEDGERS IN FINANCIAL WORLD – OPPORTUNITY OR THREAT TO BANKS?

Master of Science Thesis

Examiner: prof. Juho Kanniainen
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ABSTRACT

JUHO KURKI: Blockchains and distributed ledgers in financial world – Opportunity or threat to banks?
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The purpose of this thesis was firstly to illustrate the different views that banks and traditional institutions have on most potential blockchain use cases compared to the views of fintech companies, secondly find out how the blockchain technology could change the competitive environment in financial markets, and thirdly, give the reader a perspective of the potential of blockchains by introducing several use cases that financial institutions and fintech companies are doing research on.

We found out that banks have a positive view on permissioned blockchains due to their more congruent design with existing systems. Also the security and legal issues were seen easier to solve in permissioned blockchains. The fintech companies on their half focused on permissionless blockchains, especially the Bitcoin blockchain. This is a more economical and faster way to create blockchain-based applications.

Banks' view is that the technology works best in sectors where the amount of trust between parties is low, there are unnecessary intermediaries, cross-border payments or other barriers for efficiency. Additionally, the blockchains were seen to have biggest potential in markets where the volumes are relatively low. Trade finance, derivatives markets and post-trade settlement are examples of sectors that banks seem to have most attention on at the moment.

Fintech companies, on their half, seem to develop blockchain applications for all kind of environments. This sector was significantly more ambitious and optimistic on the new technology. Legal issues or restrictions of the technology weren't seen that big of a problem. The fintech companies seemed to have strong faith that these issues will be solved in the future.

Blockchain technology might enable a situation where need for trusted central counterparties (banks) is eliminated. Also the fintech companies might drag banks' business towards themselves. At the moment banks are in good positions as they play a major role in societies and have the resources needed to acquire promising fintech companies. In case there's cooperation in the banking sector and the banks utilize the expert workforce they can gain from the fintech buyouts, they are likely to make their functioning more efficient and will create new profit pools. Anyhow, if they fail to keep up with the development, it's easy to see them losing, at least partly, their business to new entrants. All depends of the actions that the banking industry takes in the near future.

TIIVISTELMÄ

JUHO KURKI: Lohkoketjut ja hajautettu kirjanpito finanssimaailmassa – mahdollisuus vai uhka pankeille?
Tampereen teknillinen yliopisto
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Työn tavoitteena oli ensinnäkin havainnollistaa pankkien ja fintech-yritysten poikkeavia näkemyksiä lohkoketjuteknologian potentiaalisimmista käyttökohteista, toiseksi tutkia miten lohkoketjuteknologia voi muuttaa kilpailuasetelmaa finanssimaailmassa, ja kolmanneksi antaa lukijalle kuva lohkoketjuteknologian potentiaalista esittelemällä lukuisia käyttökohteita, joita finanssilaitokset tai fintech-yritykset tutkivat.

Pankkien havaittiin suhtautuvan positiivisesti suljettuihin lohkoketjuihin, sillä nämä ovat paremmin yhteensopivia nykyisten järjestelmien kanssa ja myös turvallisuus- ja lainsäädännölliset asiat ovat helpompia toteuttaa. Fintech-yritykset puolestaan suosivat laajalti julkisia lohkoketjuja, erityisesti Bitcoinia. Tämä on selkeästi kustannustehokkaampi ja nopeampi toteutustapa lohkoketjusovellusten luontiin.

Pankkisektorilla tuntui olevan suurin usko lohkoketjuteknologia läpilyöntiin sektoreilla, joissa luottamus osapuolten välillä on vähäistä, transaktioihin liittyy tarpeettomia välikäsiä, kansainvälisiä maksuja tai muita tehokkuuden esteistä. Tämän lisäksi lohkoketjuilla nähtiin olevan suurin potentiaali markkinoilla, joissa volyymit ovat verrattain pieniä. Trade finance, johdannaismarkkinat ja selvitys- ja täsmäytystoiminnot ovat esimerkkejä sektoreista, joilla pankit näkivät eniten potentiaalia tällä hetkellä.

Fintech-yritykset puolestaan tuntuivat kehittävän lohkoketjusovelluksia lähes kaiken tyyppisiin ympäristöihin. Tämä sektori oli pankkimaailmaa selkeästi kunnianhimoisempaa ja optimistisempaa uuden teknologian suhteen. Lainsäädännöllisiin seikkoihin tai teknologian rajoituksiin ei liiemmin kiinnitetty huomiota vaan näiden haasteiden uskottiin ratkeavan tulevaisuudessa.

Lohkoketjuteknologia saattaa mahdollistaa tilanteen, jossa tarve luotetulle keskusosapuolelle (pankeille) poistuu. Myös fintech-yritykset saattavat viedä pankeilta niiden liiketoimintaa. Tällä hetkellä pankit ovat hyvissä asemissa, sillä ne ovat tärkeässä roolissa yhteiskunnissa ja niillä on tarvittavat resurssit tehdä yritysostoja lupaavista fintech-yrityksistä. Mikäli pankkisektori kykenee yhteistyöhön ja hyödyntää fintech-yritysten ostojen kautta tarjolla olevaa osaavaa työvoimaa, sillä on hyvät edellytykset tehdä toiminnoistaan tehokkaampia ja kehittää uusia tulonlähteitä. Kuitenkin mikäli pankit epäonnistuvat kehityksen mukana pysymisessä, on helppoa nähdä niiden tulevaisuudessa menettävän ainakin osan nykyisestä liiketoiminnastaan uusille tulokkaille. Kaikki riippuu pankkisektorin toimista lähitulevaisuudessa.

PREFACE

The blockchain technology is an emerging phenomenon in financial world. Writing this thesis I learnt a lot about this topic and this knowledge will certainly benefit me in the future. It was nice to notice that even in this kind of topic I could use the cross-scientific knowledge that I have gained from the field of Electrical Engineering during my studies. This knowledge helped me to evaluate a proposed use case of blockchain technology.

I want to thank professor Juho Kanniainen, who showed enthusiasm on this topic that was proposed from my side. He also connected me with the Lykke experts, and discussion with Richard Olsen, Yulia Mizgireva and Sergey Ivliev pointed out some questions to pay attention on. I also want to thank Tarja Gröroos and the rest of Nordea Trade Finance team for giving me an overview of the topic and sharing useful material.

Tampere, 9.9.2016

Juho Kurki

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS

AML	Anti-money laundering
API	Application programming interface
EBA	Euro Banking Association
ECB	European Central Bank
FED	Federal Reserve
FT	Financial Times
FX	Foreign exchange
GOS	Government Office for Science
KYC	Know-Your-Customer

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1. Introduction

Telegraphs and railroads revolutionized the trade in 19th century. After this the communication and transportation systems kept evolving and made the world smaller and smaller year after year. Financial world took advantage of the evolving technology and trading has become faster and easier all the time. In 1970's the revolution of computers exploded and trading platforms and accounting systems rapidly moved away from the paper-based procedures that had been in use since paper was invented.

Someone could have thought that the evolution of communication systems reached its climax when mobile phones started to pop up on streets in the beginning of 1990's. Internet revolutionized the society including financial systems and trading in a way that couldn't have been predicted just a couple of decades ago. Now the blockchains and distributed ledgers are taking their first steps that might end up causing as dramatic changes in everyday life of people and the functioning of financial markets.

Financial institutions are expected to spend over $1 billion on blockchain projects in 2017, making it one of the fastest evolving enterprise software markets of all time. This indicates that something is going on. Maybe the most ambitious scenarios won't become reality, but it seems likely that we will see lot of improvement in efficiency of markets and trading, as well as new services provided for customers, thanks to blockchain/distributed ledger technology. Certainly something to have a close eye on.

The automated processes enabled by smart contracts involved in the blockchain technology might be game changers in many markets. Just like the Bitcoin users don't have to trust any central party when doing transactions that the blockchain takes care of, the smart contracts could eliminate the need of having trust between trading parties in financial world. Elimination of counterparty and credit risks is something that would change the nature of markets.

The fact that in the future there might not be need for trusted central parties either is both times promising and frightening to banks. On one hand they can benefit a lot from the new solutions provided by blockchain technology but on the other there's a chance that they would run out of many parts of their traditional business. If people and corporates can securely and efficiently store their funds and trade different assets using blockchains, what is left for the banks? In the future central banks might even be able to issue loans straight to the blockchain-based wallets of individuals and corporates.

Digitalization is making fast progress in the financial world and banks have to be in the frontline to drive this development and to ensure their significancy also in the future. At the moment they are important part of the society and are in good position to be the drivers of the evolution. New technology might give them tools to create better services to their clients, reduce their costs and enhance their profitability to a new level.

The purpose of this thesis is to:

-Illustrate the different views that banks and traditional institutions have on most potential blockchain use cases compared to the views of fintech companies

-Find out how the blockchain technology could change the competitive environment in financial markets

-Give the reader a perspective of the potential of blockchains by introducing several use cases that financial institutions and fintech companies are doing research on

The research for this thesis was made primarily by utilizing literature. Also a couple of interviews and online discussions helped to gain overview of the topic. The material used includes several reports written by consulting companies, banks and other financial institutions as well as news articles, as this was important in order to understand their stance on the blockchain technology. Descriptive to the topic is that almost all material used was published in 2015 or 2016, which on its half indicates how new topic blockchains and distributed ledgers in financial world are. The scientific studies written on the new technology seem to discuss more the technical side of blockchains and distributed ledgers. Hash functions, encrypting methods and other low-level themes seem to have so far been more researched than the impacts new technology might have on financial markets and the whole society.

First in this thesis we get to know the basics of different alternatives of how to create blockchain platforms. Then we discuss why the blockchain should be implemented to financial markets. Next we open the view that banks have on the technology and after this we examine how the fintech companies' point of view differs from the banking sector's opinions. We also take a look on how the competitive environment in the financial markets could change because of blockchain technology. Jurisdiction and regulation are an important part of financial markets and this sector is discussed in chapter 7. The next chapter is lengthy and important as it consists of nine potential use cases for the blockchain/distributed ledger technology. These different use cases give an overview of the potential and various segments in which the technology could be implemented to. Chapter 8 also speculates how the competitional environment in the financial world might change as new fintech companies enter markets traditionally dominated by banks. In the next chapter we discuss whether the blockchain hype is already overheating and eventually we drag everything together in the final chapter, Conclusions.

2. Blockchain technology

In this chapter we gain a basic knowledge of important aspects that have to be considered when designing financial platforms that utilize blockchain technology. The idea isn't to go through the technical specifications of the technology. Instead, this chapter gives information that is necessary to be able to understand the potential of the blockchains and distributed ledgers.

2.1 Distributed systems

In a distributed system all nodes are equal and they are connected to several other nodes. This is different than in centralized or decentralized systems where, as seen in Figure 1, are one or more central nodes.

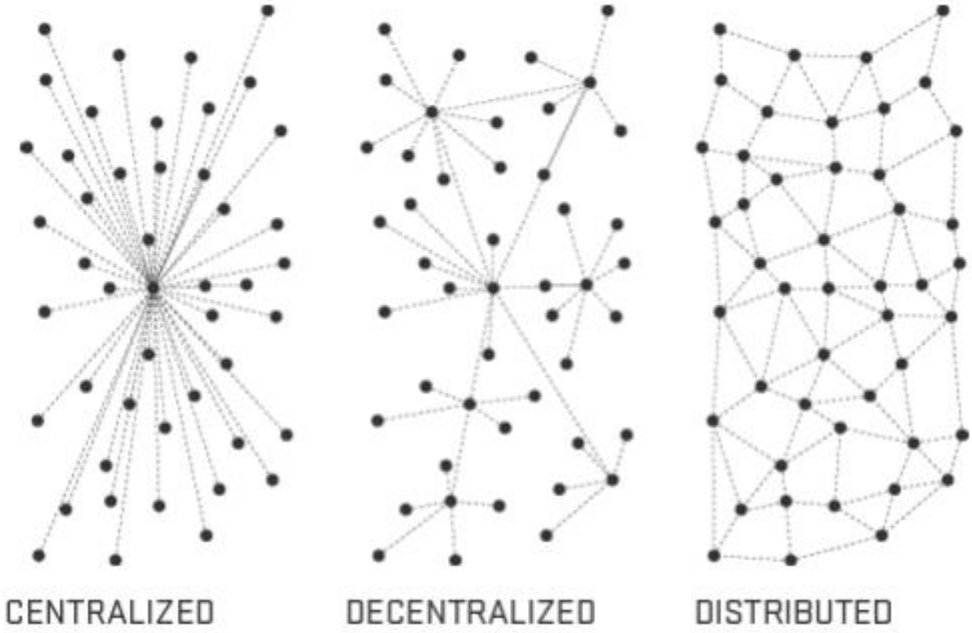


Figure 1. Centralized, decentralized and distributed systems. Swanson 2015, p.1

There are several benefits on distributed systems in comparison to centralized ones. Centralized systems are often more efficient from a technological point of view, but they are more vulnerable to some threats. The failure of a central server will cause a failure of the whole system. The administrator of the database/hardware bears a great operational risk, and has a great power in controlling and the system and unilaterally creating the rules. Centralized solutions also create monopolies, which often lead to inefficiencies. This might drive the business costs up as the monopolist has no incentives to contain them. In financial world the centralized solutions also generate a concentration of

financial risk, which leads to increased need and cost of risk management. (Morini 2016, p.3)

Distributed ledger system is a new kind of platform that typically utilizes the cryptocurrency-inspired technology. A centralized ledger has the disadvantages of centralized systems stated above and also raises the likelihood of legal disputes, as the administrator of the database/ledger can be accused of manipulating the ledger. The ledger should report the situation to everyone and yet not belong to anyone, so a distributed solution is perfect in this sense. The ledger downloaded by one party is similar to the versions that other parties hold. (Morini 2016, p.3)

Situation where two parties involved sign a contract and validate transactions on a private distributed ledger is a basic extension of the current reality. This would already improve the efficiency of financial markets, and would significantly decrease the need of litigation and reconciliation. Massimo Morini (2016, p.5) sees that it would anyhow be shortsighted to focus on bilateral solutions as the technology would allow to create even more efficient solutions. Many services can benefit from multilateral distributed validation and recording. For example, some business cases can be provided or guaranteed by a third party. Speed and transparency of a multiplayer ledger can improve this kind of processes. They could also offer the regulators a broader and deeper vision on the markets. Morini points out that these kinds of credit-related business cases are still out-of-sight, as the existing operating models are different, but sees that these have a chance to evolve in the future.

2.2 Permissionless and permissioned blockchains

Cryptocurrency systems can be divided to “permissionless” and “permissioned” systems. (Swanson 2015, p.7) Permissionless, or public currencies such as Bitcoin, Ethereum or Peercoin, for example, have their transaction history book, the ledger, on a public, untrusted network. This accommodates pseudonymous actors.

Bitcoin is often used as an example of the distributed ledger/blockchain technology, as it is so far the best and most widely spread proof that this technology can be efficiently implied. The whole functioning of Bitcoin is based on the work done by miners. Their mining hardware is working on solving a mathematical problem. In case a miner finds the solution for this problem, there will be a new block added in the blockchain. This is called “finding a block”. The recent Bitcoin transactions are stored into the new block. In this way the transactions will be validated and end up in the distributed ledger. In case there would be no miners searching for new blocks, the Bitcoin transactions couldn´t be validated anymore and the system would stop working.

Bitcoin miners get a reward for each block they find. The block finding reward is halved every four years. The incentive for mining can also be funded with transaction fees. It's predicted that the significance of transaction fees will increase in the future as the block rewards fall. This is illustrated in Figure 2.

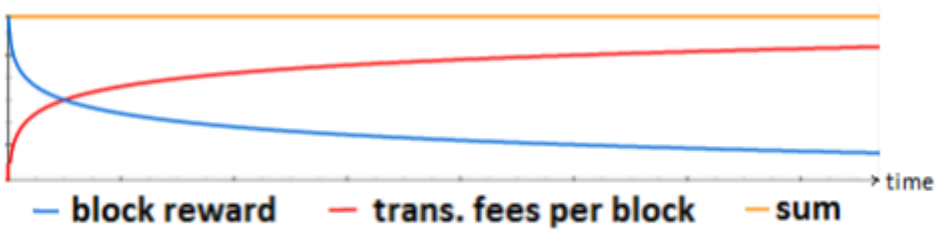


Image credit: Kerem Kaskaloglu

Figure 2. The prediction of development of mining rewards. Swanson 2015, p 10

However, in practice this kind of phenomena isn't distinguishable yet. So far (June 2016) there has been one block reward halving. As seen in Figure 3, the transaction fees have remained rather flat even though they have risen a little from the beginning of the blockchain.

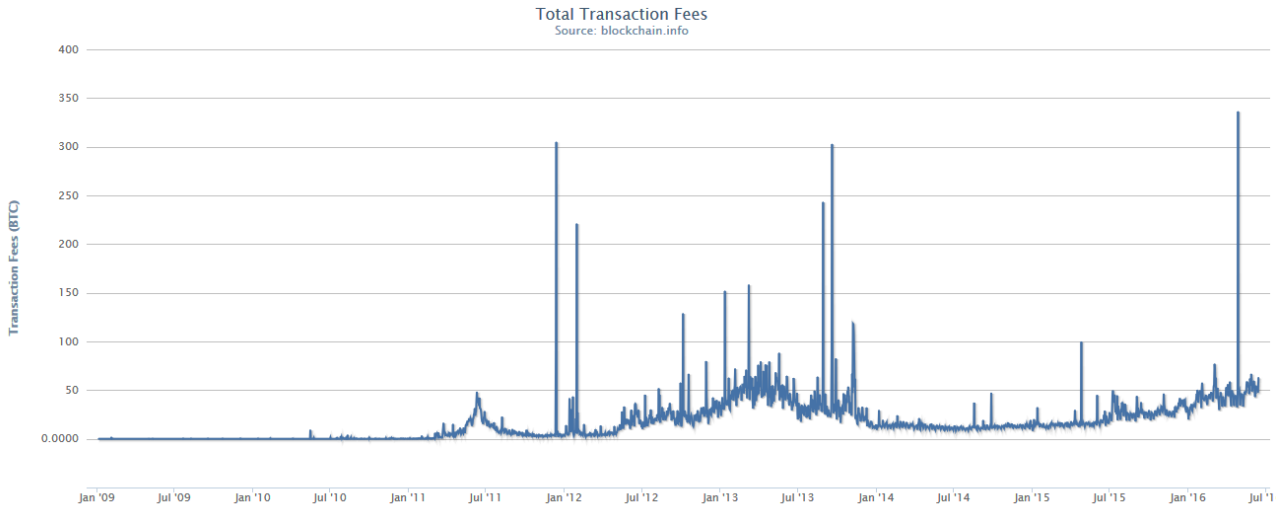


Figure 3. Total transaction fees of blockchain. Blockchain.info 2016.

The diminishing block finding rewards and high transaction fees are one potential threat for the existing cryptocurrency blockchains. These threats relate also to applications that are based on these blockchains, the colored coin technology, that is discussed later in this thesis, for example. Anyhow, large institutions (using e.g. a colored coin –based applications) also have large resources and can adopt to the rise of transaction fees better than private users. In other words, they can ensure that their transactions will be more likely to end up in the blockchain than the transactions of smaller players. This makes the use of applications based on permissionless blockchains more reliable for institutions. Anyhow, the rise of transaction fees is one potential risk for organizations considering

the transfer into platforms that rely on permissionless cryptocurrency systems. It is also possible that the seigniorage will drop to zero, fees stay constant, and the blockchain will end up insecure and continuously forked. (Swanson 2015, p.11)

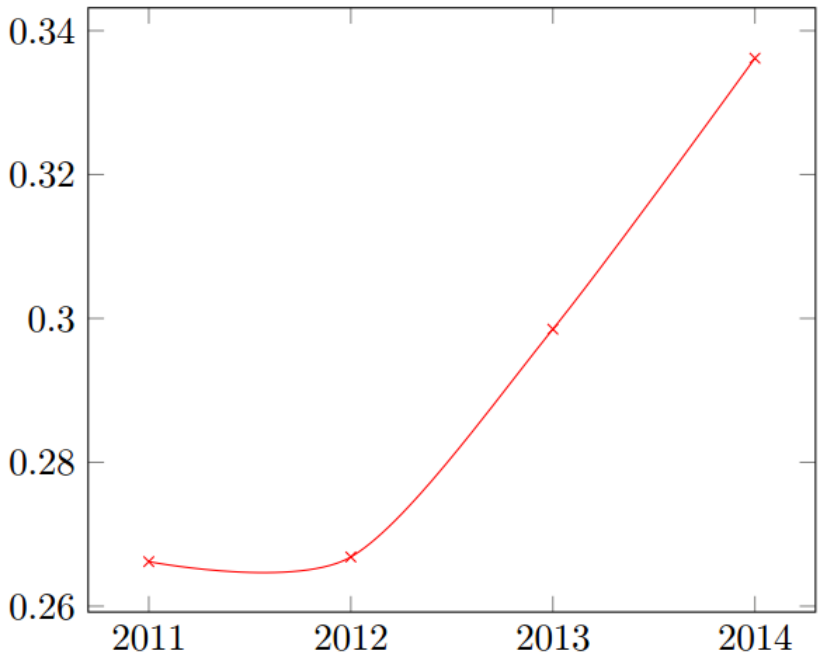


Figure 4. Trend of centralization in Bitcoin mining. Beikverdi & Song 2015.

The mining, in other words, maintenance of the Bitcoin blockchain has become more centralized during the past years. Beikverdi & Song (2015) created a formula to calculate the centralization percentage of the mining process. 0 is an absolutely decentralized system whereas 1 represent completely centralized solution. The results of the calculations can be seen in Figure 4. Beikverdi & Song say that centralization is a natural phenomenon in systems, and in the case of Bitcoin it's widely explained by the economics of scale in mining infrastructure investments and on the other hand the introduction of mining pools, where different miners combine their mining power in order to have a reasonable chance of finding blocks as the difficulty of mining increases.

The centralization trend is a threat that has to be taken seriously. Especially the risk of one party getting into position of holding over 50 percent of the mining capacity would likely be fatal for the blockchain as this party could then individually alter the rules of the blockchain. Even though this scenario isn't that likely to happen, anyhow the centralization development is something that organizations must take in account when considering whether they can rely on a system based on a permissionless blockchain like Bitcoin.

The obvious upside of permissionless cryptocurrency systems for the organizations is that no hardware investments are needed and therefore it's an economical option. Building up a system based on an existing permissionless blockchain isn't very time-taking procedure

either. The public distributed ledger also offers a truly transparent record of the transactions for all participants. In some cases this might also be a downside as the institutions might be willing to have a ledger that is only visible for its associates.

The permissioned cryptocurrency systems, like Hyperledger or Ripple, avoid some of the downsides that the permissioless systems face. Permissioned systems offer better opportunities to control the publicity of the ledger.

		Who do I trust to maintain a truthful record?			
		A central authority	**A group of known actors**	**A group of actors, some known**	**Nobody**
What is the universe of "things" I need people to agree on?	**Ownership of on-platform assets**	Central Bank, Commercial Bank		Ripple (XRP)	Bitcoin
	Ownership of off-platform assets	Custodian Bank	Hyperledger	Ripple (Gateways)	Colored Coins, Counterparty
	Obligations and rights arising from an agreement	Clearing House	Eris	Ripple (Codius)	Ethereum

Chart 1. Different natures of blockchains. Swanson 2015, p.12

In Chart 1 is one illustration of the different natures of blockchains. The permissioned systems are likely to be more secure and reliable in the future. Anyhow these systems require trust towards the counterparties of the system. For example in Hyperledger, which is an open resource distributed ledger framework and code base for enterprises, the users of the platform are members of the Hyperledger Project, and therefore they are all known. (Hyperledger 2016) Ripple is an example of a platform where it's possible to make transactions between both known and unknown counterparties.

Accenture (2015a) illustrates the differences of permissioned (private) and permissionless (public) systems by comparing the permissionless systems to internet whereas the permissioned systems are being compared to intranet. Chart 2 portrays the differences.

Public DCL	Private DCL
Permissionless ledger—anyone can use it and innovate with it	Permissioned ledger—only a closer group of organizations can participate
'Proof of work' consensus	Custom consensus engine—rules set by the participating organizations
Public nodes	Private nodes (closed group)
Cryptocurrency token	Optional token
Open wallet access/internet	Closed wallet access/VPN
Cost of using it is low	All running costs need to be met by the participating organizations

Chart 2. Characteristics of public and private distributed ledgers. Accenture 2015a, p. 17

There's various trade-offs between permissioned and permissionless systems. There are differences in speed, cost reduction, censorship and finality. The permissioned systems are capable of handling the clearing and settling of assets faster and cheaper. Additionally, due to their more congruent design with the existing banking system, they offer more potential for financial institutes. This includes jurisdictional aspects, as permissioned systems can better fulfill these needs. The major problems with permissionless systems are the use of anonymous validators and their vulnerability to transaction reversals by an anonymous attack. (Swanson 2015, p 6)

2.3 Colored coins

Many promising applications on the blockchain/distributed ledger technology created especially by the startups rely on the use of permissionless blockchains. Especially the Bitcoin blockchain is widely utilized. The colored coin technology is one technology that is often being used.

The colored coins can be formed from any part of Bitcoin or other cryptocurrency. One BTC can be divided to 100 million parts, the smallest possible part being called a *satoshi*. As the BTC has been traded in prices under $1000, the value of a satoshi is neglible. Anyhow it´s possible to store data into a satoshi. This data can be for example a smart contract, or simply a commitment made by a party, say a bank, to pay $100 for the holder of this particular colored coin. The advantages of this kind of approach are clear; it´s very cost-efficient and rather easy to build and customize this kind of platform to the needs of a company. This is because the maintenance of the blockchain is done by miners, and the colored coin users simply utilize this existing blockchain.

The downside of colored coin –based applications (or any other technologies that are based on permissionless blockchains) is that any potential threat for Bitcoin is a potential threat to applications based on the Bitcoin blockchain. Therefore it´s important to

understand the risks related to permissionless blockchains. There are also lots of open questions in Know-Your-Customer (KYC) and Anti-money laundering (AML) issues as the Bitcoin and other permissionless blockchains were designed for anonymous use. The use of colored coins in financial solutions is opened more in the IATA Clearing House example in chapter 7 of this thesis.

2.4 Smart contracts

As we find out later, smart contracts are very important tools provided by the distributed ledger/blockchain technology, as many potential use cases of the new technology utilize different kinds of smart contracts. In theory, they can be valuable tools at both an interoperability level and application level (e.g., representation of a financial contract) depending on specific instances. There are still several jurisdictional questions unanswered. It remains to be seen whether the smart contracts will be viewed as actual legal contract. (Swanson 2015, p. 16) Pinna & Ruttenberg (2016, p. 18) says that when the blockchain/distributed ledger technology is applied to financial markets, the smart contracts may prove to be the element that causes real change.

Smart contracts can be created in every blockchain that that is built to support them. For example, Bitcoin only has the very basic smart contracts. This limits its potential in the financial world. Other blockchains, like Etherium are more developed. Ethereum has smart contracts written in a Turing-complete language, which means that it can do anything that a normal computer can do. (Morini 2016, p.2)

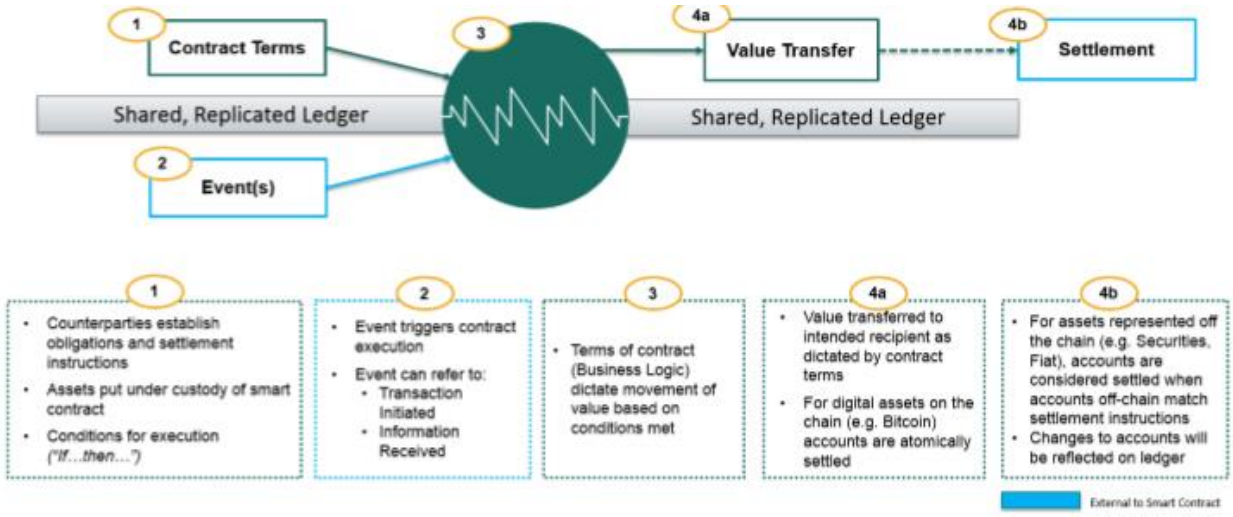
Tim Swanson has described smart contracts to be "computer protocols that facilitate, verify, execute and enforce the terms of a commercial agreement". Richard Brown's definition is that "a smart contract is an event-driven program, with state, which runs on a replicated, shared ledger and which can take custody over assets on that ledger". (Swanson 2015, p.15)

Smart contracts can be used for processes that require automatic transactions, for example crediting a dividend or coupon payment, issuing and reacting to margin calls, or optimizing the use of collateral. These transactions are carried out automatically and stored in the ledger in response to a specific corporate action or market event. (Pinna & Ruttenberg 2016, p.18)

Smart contracts are a step towards a more advanced market. In addition to more efficient accounting and reporting of transactions, a contract stops being two pieces of paper. Instead it will be a piece of code that is cryptographically signed by the counterparties. Already at the moment financial contracts are translated into software running on IT systems, but in the future they could exists only in a distributed ledger system. (Morini 2016, p.2-3)

A smart contract can have access to several accounts and transfer assets according to the terms of the contract immediately when an event triggers the application of such transfers. The event can come from inside or outside the blockchain. Once a party has created a smart contract, the counterparties may accept it and make it executable. The agreement between the parties is thus validated, and can´t be cancelled. The consequences of a smart contract can´t be ignored, as the code of the contract automatically and immediately does the predefined transactions when an event that triggers its execution happens. (Pinna & Ruttenberg 2016, p.18)

By using smart contracts counterparties can make agreements without the need of reimplementing the terms of the contract into their own systems. The smart contract is running on a shared, distributed ledger, and therefore the outputs of this program are similar to all the counterparties. The smart contract can receive and store inputs, like value and information, and it can send out different, predefined outputs. This is illustrated in Figure 5.



Source: Jo Lana / R3 CEV

Figure 5. The structure of smart contracts. Swanson 2015, p. 18

Tim Swanson (2015, p.16) found several possible uses for smart contracts. In Cross Border Settlement / B2B international transfers smart contracts could improve the SWIFT and correspondent banking network, as they can securely and transparently move value in seconds using consensus-as-a-service or blockchain-as-a-service technologies. The biggest challenges observed by Swanson are local pools of liquidity, settlement with market makers and jurisdictional questions.

One example of the legal questions that have to be answered whether the blockchain/distributed ledger is used to record assets that are native to the ledger (tokens) or claims that refer to off-ledger assets. In case of tokens the procedure seems pretty clear,

but when it comes to off-ledger assets, the consequences of an update to the ledger are less obvious. Legislators need to solve the issues considering e.g. the effects on ownership rights. (Pinna & Ruttenberg 2016, p.21)

Central clearing is another possible use for smart contracts. This is a prime case for "multi-party payments and netting/clearing. Smart contracts might also be useful in handling mortgages. If a single bank is trusted, there is no need for the blockchain or distributed ledger, but it will be increasingly useful in situations where the banks or other third parties aren't trusted to maintain a fair register, e.g. in installment payments. Blockchain offers the possibility to have a financial vehicle that self-executes and can be used by several parties. It might be useful in collateralized debt obligations (CDOs). Main challenge is the enforcement in case of non-payments. Smart contracts may have use in collateralized / guaranteed lending, but in these cases the decentralization may not offer benefits without identity and credit checks. (Swanson 2015)

There are use cases is in Letter of Credit, Bill of Lading and Trade Finance solutions, as in these cases multiple parties are involved, the trust between the parties is low and the cost of transactions are high. There are multiple jurisdictions though, as the parties are operating in different nations, which is a major challenge. Smart contracts might also facilitate Crowd Funding if the legal constraints are solved. At the moment there's not many smart contracts in use, so it will remain to be seen in the future how well they will work in financial solutions. (Swanson 2015)

2.5 The trust issue

The concept of trust is in the spotlight when talking about the blockchain/distributed ledger systems. Bitcoin was created to work in such a way that the counterparties can remain anonymous, they need to have no trust between each other and can do without any legal protection. In financial world, the operations are built on different levels of trust, and on the other hand, the jurisdictional questions are important. (Morini 2016, p.1) It's good to keep in mind that the financial world has never had full amount of trust between the players. Interest rates, exchange rates and prices of assets have always varied depending on trust between the parties involved, let them be central banks, nations, financial institutions or private people.

Mainelli & Smith (2015) point out that in reality, financial services trade on mistrust. If people trusted on each other on transactions, many financial services might be redundant. The trust issue is has become even more significant in the markets; as more and more transactions are done online, the trust between the counterparties have to be maintained in more developed ways than before. It's different kind of procedure for example to make a purchase from an online store than a supermarket.

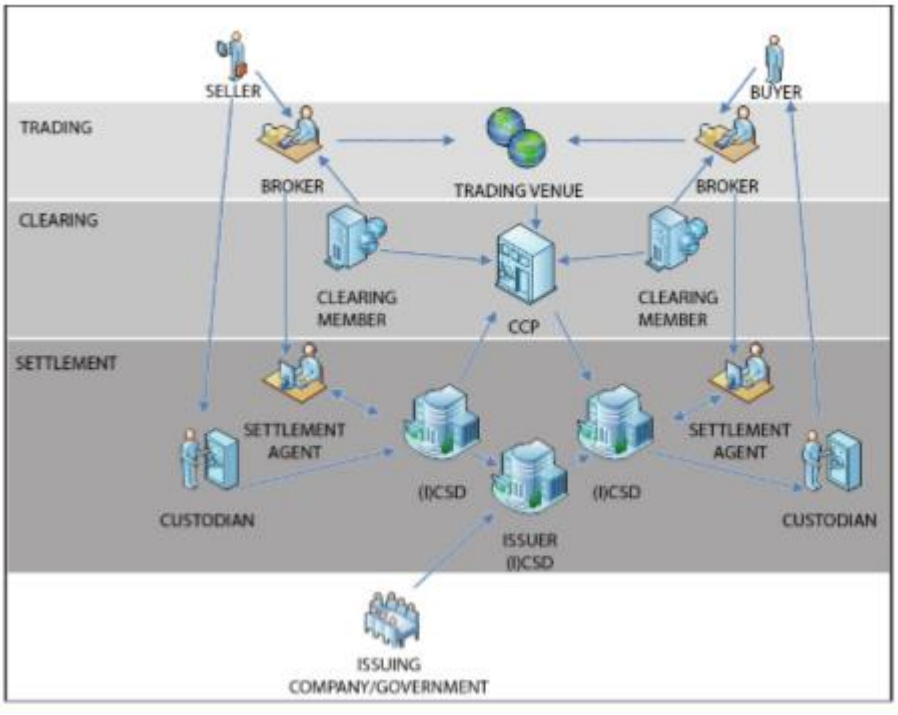
In Bitcoin, a significant part of the algorithm is the solution for avoiding double spending. This means that a coin can only be used once, so that the user can't make payments to several parties using the same coin. As the transaction of the coin is recorded and verified in the blockchain, the users can't send the same coin again to anyone else. In financial world, where the participants are verified, one could think this isn't a similar kind of a problem, and therefore no need for this kind of validation would be necessary. But again this leads to the concept of trust. Actually, double spending always has and always will be a risk also in the financial world. It is just named differently, we call it a default. In default a corporation has promised payments that are higher than the funds they actually hold. In other words, they have done a double spending, making a promise of transaction of funds they don't have.

Default risk is continuously present in the markets. As we have seen, also the biggest and most trusted parties have ended up in default. The transparent distributed ledger offers improvements in handling this risk, as the situation is better viewable by regulators and associates of the corporations and other parties involved. (Morini 2016, p.5) The blockchain technology and smart contracts could revolutionize several markets as the automated processes and contracts with predefined outputs eliminate the need for trust between the counterparties.

3. Motivation for the use of blockchain technology in the financial world

Blockchain/distributed ledger technology is still in its early stage of development, but despite this, financial institutions believe that it can reduce significantly the complexity of bank processing as well as replace expensive database and middleware processing applications. Additionally, blockchain technology supports fast multi-entity transaction clearing and settlement, and enhances fraud prevention and AML protection. These opportunities have motivated many financial institutions to research blockchains in order to increase efficiency of banking and gain cost reductions at a time when profitability is under real pressure from growing IT and operational costs, and falling revenue. (Blower et al 2016)

The motivation to use blockchain/distributed ledger technology in the financial markets is widely related to its potential in increasing efficiency. One part of increasing the efficiency is eliminating intermediaries.



Note: (I)CSD = (international) central securities depository, CCP = central counterparty.

Figure 6. Post-trade processes in the securities leg of current transactions. Pinna & Ruttenberg 2016, p.20

In Figure 6 there is an illustration of the security leg of a securities transaction between end-investors. As we can see, there are several parties involved. Each of the steps seen in the Figure might also require the party´s records to be reconciled with those of other parties at different levels of the value chain. A transparent, distributed ledger would provide real-time updates of the trade to all members of the ledger eliminating the need for such a many validations and parties. Anyhow, the market players are often willing to keep their trading strategies confidential, and therefore the distributed ledger technology is being developed in order to allow confidentiality to be maintained in the trading process. (Pinna & Ruttenberg 2016, p.24) The distributed ledger might also allow that the securities could be held directly by the final investors.

Functioning of financial markets is based on "consensus-by-reconciliation". All counterparties need to store the transactions to their own ledgers and IT-systems. The verification of the transactions involves several steps. This is a bottle-neck that makes the process inefficient despite the technology would enable fast communication in between the parties. This process hasn't really changed in financial world during the decades. The distributed ledger, or distributed consensus of the transactions is what makes the Bitcoin payments so fast and efficient. (Morini 2016, p.2-3)

Blockchains could offer totally new kind of business models and products to financial markets. As Panayi & Peters (2015, p.2) say, "the technology has the potential to revolutionize contract law and processing via self-enforcing digital contracts, whose execution does not require any human intervention." Blockchains could enable the creation of totally new kind of solutions, that one can't even imagine today.

The potential cost savings gained by blockchain/distributed ledger technology are huge. As Morgan Stanley (2016) says, a shared transparent database that makes the data irrevocable and auditable can reduce the teams of people in around six firms that are responsible for approving and authenticating each transaction. Users can also share costs of building and maintaining the infrastructure, which leads to additional savings. They cite Blythe Masters, who says that in its use cases the new technology might bring the costs of financial institutions down 30-50%.

Class	Examples
General	Escrow transactions, bonded contracts, third-party arbitration, multiparty signature transactions
Financial transactions	Stock, private equity, crowdfunding, bonds, mutual funds, derivatives, annuities, pensions
Public records	Land and property titles, vehicle registrations, business licenses, marriage certificates, death certificates
Identification	Driver's licenses, identity cards, passports, voter registrations
Private records	IOUs, loans, contracts, bets, signatures, wills, trusts, escrows
Attestation	Proof of insurance, proof of ownership, notarized documents
Physical asset keys	Home, hotel rooms, rental cars, automobile access
Intangible assets	Patents, trademarks, copyrights, reservations, domain names

Chart 3. Potential blockchain applications. Swan 2015, p.10.

As seen in Chart 3, the blockchain could be applied to numerous different uses in financial world. The new technology might enable automated markets providing revolutionary new business models in these fields.

Mori (2016) stated the motivation for blockchain use in couple of bullet points: Near real-time settlement, low costs, traceability, encryption, accuracy and reliability. The benefits depend on the use cases; for example, it's clear that several markets already have a fast settlement but in some sectors the blockchains could reduce the settlement window several days, even weeks. The encryption, or cryptographic proof of transactions replaces the need of trust between parties, and traceability, accuracy and reliability are natural results of the transparent distributed ledgers. These qualities are important in all financial markets

The European Securities and Markets Authority says that a distributed ledger has the potential to reduce counterparty risk, operational risk, legal risk and risk of cyber-attack during the post-trade period, which is of particular interest to the financial regulation authorities.

Also The Commodity Futures Trading Commission has drawn attention to the benefits of distributed ledgers for transparency and maintaining all of the trade records. It even states that the 2008 financial crisis could have been avoided with distributed ledger use. It says that the "records powered by distributed ledger technology and held by trading counterparties (and available to regulators) would have accurately shown Lehman's open positions across asset classes. Imagine if, instead of requiring countless legal actions spanning eight years, we could have known all of Lehman's exposures within minutes of its bankruptcy filing." (Mori 2016)

Morgan Stanley (2016) and Goldman Sachs (2016), among others point out that fraud reduction is one of the assets of blockchain technology. Assuming that the financial

institutions use a permissioned system with validated users, the multi-node architecture of the ledger makes it more difficult for corruption to go unnoticed.

The blockchain technology definitely is on its way to financial markets. For example, Nasdaq has already deployed blockchain technology for the trade of unlisted stocks (only issuers and investors are members of this scheme). (Mori 2016). Nasdaq's plan for the blockchain is to replace the current paper certificates system, with a lowering of cost and a gain in speed of having the initial public offering. (Centers & Fanning 2016) Also the Australian Securities Exchange plans to commence a post-trade pilot scheme for blockchain in around July 2016. (Mori 2016).

Morgan Stanley (2016) sees that the timespan of blockchain/distributed ledger technology development is about a decade. Already at the moment there is great interest towards the technology, as financial institutions have realized its potential. Several organizations to develop the system have been established, like R3 and the Linux Hyperledger Foundation. Morgan Stanley sees that during years 2016-2018 is the Proof-of-Concept time period, where several test cases on specific assets, like CDS, Repo settlement, Corporate syndicated loan settlements, Trade Finance and International currency transfers, as well as in post-trade settlement fields will be executed.

It predicts that in 2017-2020 the shared infrastructure is starting to develop, and the proven assets will be traded on these platforms in increasing amounts. Interfaces for external users become workable and the costs of the settlement process starts to decrease. In 2021-2025 more and more assets move onto blockchain as the efficiencies prove out. Financial institutions are expected to spend over $1 billion on blockchain projects in 2017, making it one of the fastest evolving enterprise software markets of all time. On the other hand, the same report says that many banks have been slow to respond to the emerging technology, because of the poor profitability of Western banking, technology investments with payback time over three years haven't been an appealing option. Santander on its half suggests that the blockchain technology might reduce financial infrastructure costs by as much as $20 billion by 2020. (Mori 2016) Centers & Fanning (2016) have similar predictions, saying that Blockchain could save financial institutions at least $20 billion annually in settlement, regulatory, and crossborder payment costs.

Mori's (2016) view on the timespan that the introduction of blockchains to financial markets needs is coherent with the view of Morgan Stanley. He says that for the blockchain to be fully deployed into financial markets will take more than a couple of years but less than a decade.

Also Goldman Sachs (2016) has same kind of view, saying that they expect to see early stage technical prototypes within the next two years, with limited market adoption in 2-5 years and broader acceptance in 5-10 years. The reason why broader market acceptance

is likely to a decade are the regulatory oversight required and large number of market participants in large-scale markets like equities.

4. Banks´ views of the blockchain technology

4.1 Pemissioned or permissionless systems?

The characteristics of permissioless blockchains fit perfectly the needs of Bitcoin. Pseudonymity of market participants, immunity of supervisors, the distributed ledger being accessible to anyone, and also the irreversibility of transactions, even if they were unlawful, are great qualities when developing an "semi-anarchist-type" currency that is not dependent on any central party and whose use can´t be regulated or supervised. Anyhow, all these qualities are something that the financial institutions don´t need. Instead, they need a system that, in addition to being reliable, efficient and not too costly, is compatible with the standards they are required to meet, for example, the KYC and AML rules. Other requirement is that the system is transparent to the regulators. This is something that can be achieved by using permissioned blockchains say Pinna & Ruttenberg (2016) from the ECB. The characteristics of permissioned and permissionless blockchains are illustrated in Charts 4 and 5.

Permissioless blockchains

Strengths	**Weaknesses**
-Cost efficient (no big hardware investments) - Easy and fast deployment into different circumstances -Completely transparent and accessible to everyone	-Dependent on the reliability/stability of the cryptocurrency blockchains (e.g. Bitcoin or Ethereum) -Designed for pseudonymous actors (legal, governance, AML issues) -The blockchain can't be developed to better fit the needs of financial institutions -Less efficient
Opportunities	**Threats**
-Technical development in the future could solve many of the issues	-Have only functioned some years so far so the future is unclear (no one is in charge of its maintenance) -Vulnerable to 51% attacks / Centralization of mining -Might become unreliable in the future

Chart 4. SWOT-analysis of permissionless blockchains.

Permissioned blockchains

Strengths	Weaknesses
-All users are known & only desired users involved -Can be built to fit the needs of the use case -Can be later modified more easily if the participants desire to do so -More efficient -More secure	-Cost and time needed to create a new platform -Not as transparent (can be also a strength in many cases) -Difficulty to agree on industry-wide standards might be even higher
Opportunities	**Threats**
-The banking industry might agree on standards quickly -Legislators more assumably more willing to accept permissioned blockchains	-Permissionless systems can be created quicker → they might gain a dominant position making the resources spent on permissioned systems go to waste

Chart 5. SWOT-analysis of permissioned blockchains.

Also Morini (2016, p.1) admits that Bitcoin found a decentralized solution for chronological tracking and time-stamping that serves the needs of pseudonymous actors. He doesn't see much use for Bitcoin for financial institutions, but says that the distributed technology and blockchain will be useful in this sector as well. Especially the asymmetric public-private key cryptography is pointed out to be useful for financial markets, as it is already used in many fields. This form of cryptography may decrease the need of intermediation, and Bitcoin for example uses it to disintermediate banks as providers of cash deposits. Morini (2016, p.4) sees, though, that in financial world it´s unlikely that banks nor their financial counterparties could be disintermediated without a decrease of security.

This view seems to be dominant among the traditional financial institutions. The Morgan Stanley report (2016) says that not a single policymaker they met would allow an permissioless distributed ledger. Neither they found any banker that would value the anonymity or decentralized system. In other words, they don´t see use for Bitcoin in financial world either.

Goldman Sachs (2016) also expects that the permissioned blockchains will dominate most of the commercial applications. The issue that in many cases the trust between the counterparties is already established in the financial world and additionally data privacy is important in these markets is pointed out. Therefore the permissioned blockchains will be the most suitable in e.g. high-volume transactions such as securities trade. Also in sharing information between commercial partners in a supply chain the permissioned systems are seen to be the best option.

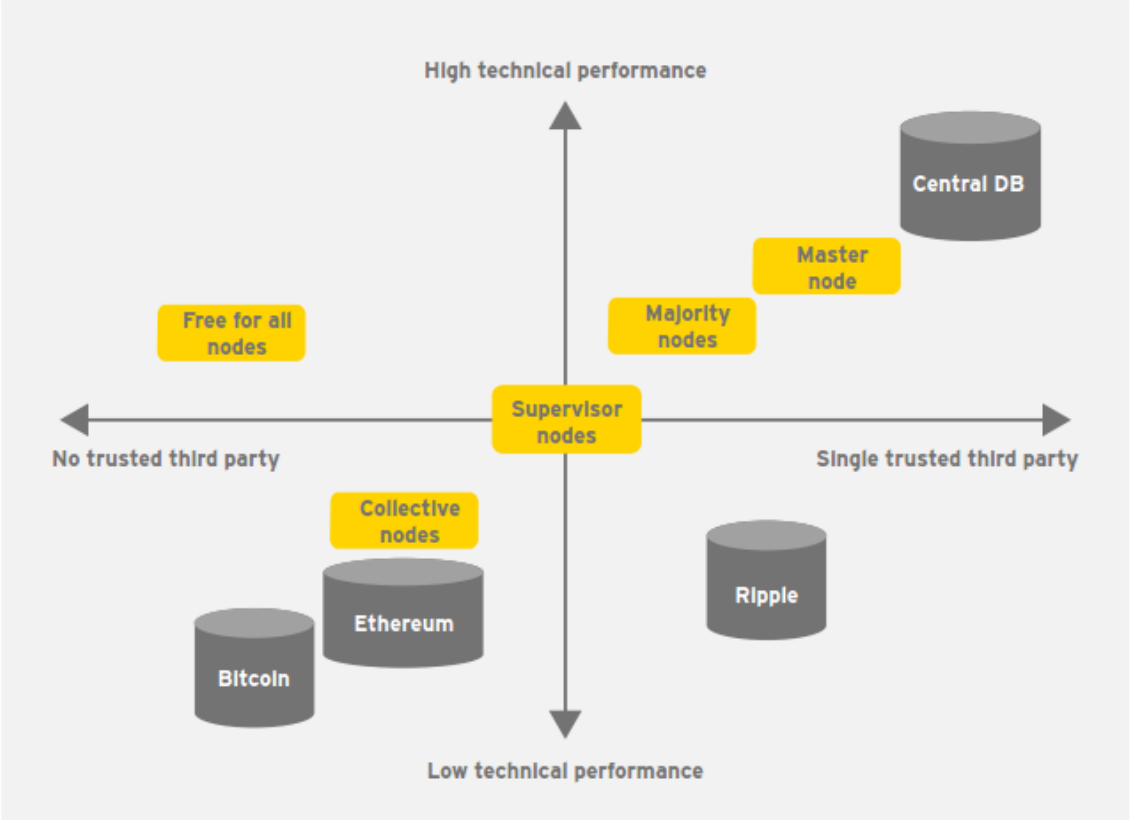


Figure 7. Low-trust blockchain architectures have significant performance costs. Mainelli & Smith 2015.

Mainelli & Smith (2015) point out that in financial systems the trust is often a synonym for efficiency. This is illustrated in Figure 7. As seen there, the cryptocurrency blockchains, Bitcoin and Ethereum are in the bottom sector of the Figure, meaning that their technical performance is low. This is one explanation of why the financial institutions aren't that interested in utilizing permissionless blockchains.

The regulation especially in AML and KYC sectors are in Morgan Stanley's (2016) opinion the most difficult ones to carry out in an permissioless system. There's also consumer security concerns related to systems with anonymous players. The KYC and AML issues could be solved in a permissioned system if it´s possible to find a single

digital identity passport authorizer. Therefore **Morgan Stanley sees that the markets with a relatively small number of players to work together have the highest potential for the use of the new technology.** This view is dominant within financial institutions and is one reason why it´s not likely that the new technology will be applied in e.g. in customer payments very quickly.

Interestingly, as the AML issues are often seen to be the most difficult hurdles in adopting blockchain, Accenture (2015) says that the technology could actually be used to improve the supervision on this sector. Also Goldman Sachs (2016) says the same. In order to do this, anyhow, permissioned blockchains seem to be the only option as AML isn't possible to carry out in in permissionless system where the identity of the nodes isn't known.

Also ECB (Pinna & Ruttenberg 2016, p.12) shares the view that permissioned systems would fit the banking industry whereas permissioless wouldn´t. The financial industry has developed over time into a network of mutually trusting players. Legal and regulated processes are present in this network in order to avoid risks. Each institution trades with accountable and authorized counterparties under the supervision and oversight of regulators.

Safety issues are another factor that explains banks being more open towards the use of permissioned systems. A wrongdoer can be identified and punished for its frauds through legal paths. In a permissioless system the wrongdoer can't be punished outside the ledger, and even sanctions within the ledger aren't easy to apply, as it probably would require deleting transactions from the blockchain. This could be executed if majority of the network would decide to do so, but it would raise questions about the reliability of the whole system, as the Pandora's box for blockchain manipulation would now have been opened. There's no possibility to pose sanctions like fines or risk of lost reputation as the identity of the members isn't known.

4.2 Proof of work/other validation technologies

The lack of off-ledger incentives leads to the need of the ledger members to deploy their resources to deter the validation of illicit transactions, say Pinna & Ruttenberg (2016) from ECB. There´s different ways to do this, one possibility is the use of computational power, like in Bitcoin. This is called proof-of-work technology. Miners, the "administrators" of the blockchain, solve mathematical problems and earn a reward from it. This is an incentive for the miners to update the blockchain in honest way even though, as being anonymous, they can't be forced to do so by a reputation incentive. There aren´t any legal liabilities either for the miners to do so.

In financial world the players are not anonymous and a fraud will be legally prosecuted. The situation therefore is in many ways different. There´s no reason why the proof-of

work –method couldn't in theory be used also in the financial world, but it isn't an efficient choice. In Bitcoin, the miners have to invest in mining hardware and energy. This investment doesn´t go to waste because as explained earlier, the proof-of-work mining is crucial to keep the blockchain updated in the Bitcoin platform.

In financial world, however, the commitment for crucial players is already proved and they have an incentive to maintain the credibility of the whole financial system. Their reputation, for example, affects many parts of their business. The proof-of-work validation would be waste of resources and therefore it´s possible that the technology won´t be used in financial world for a very long time. In a permissioned system, where the security can be maintained by jurisdictional and regulational methods, there´s no need for these kind of investments, which is another factor that makes a permissioned system more appealing option to financial institutions.

Blower et al (2016) also say that the proof-of-work validation, at least the way it's executed in existing blockchains isn't suitable to financial markets. They state that "when applying blockchains to financial solutions, new features need to be incorporated such as using high-speed communication networking instead of P2P, and fast consensus protocols should be used rather than the mining process used in common blockchain systems."

Other validation technologies, especially the proof-of-stake validation have been under discussion, but there hasn´t been functioning solutions based on this technology yet. It remains open whether the proof-of-work technology will have a competitor in the future.

4.3 Challenges of implementing blockchain to financial markets

Morgan Stanley (2016) says that every time they talk with the C-suite of financial institutions, the challenges of implementing the blockchain/distributed ledger technology pop up in the discussion. There are several hurdles in making the blockchain implementation reality. All of these hurdles can be surmounted, but anyhow adopting the new technology will be a long-lasting operation. IT infrastructure changes are always time-taking processes in big institutions, even if no completely new technology, like the blockchain, is implemented. Morgan Stanley mentions Commonwealth Bank of Australia, a well run bank, as an example. It took five years for it to install a new IT system. The challenges rise a question whether the use cases could be better handled by using the existing platforms, especially as there's always a risk related to the functioning of new systems.

The blockchain technology works with almost real-time settlement, which can in many cases be a challenge as well. One major problem area is short-selling, as this is enabled because of the settlement time of several days. Typically, the covering transaction is completed after several the following business day. Mori (2016) points out that the

adoption of real-time settlement would require a change in procedure of lending and borrowing securities.

The legal disputes are a topic that many parties identify as a major problem in cross-border payments, a major use case for blockchains in financial world. For example, Mori (2016) especially points out the need to take in account the bankruptcy law in the jurisdiction in which the trading partner is based, particularly with respect to institutions with international influence. As the settlement of transactions would be carried out instantly in the blockchain-based system, there could be for example a challenge as the business day might be different in the countries where the trading partners operate. Also different national holidays, or other such issues are an aspect that needs to be taken into account. The blockchain would be likely to require a 24/7 functionality in order to work efficiently, which would differ from the existing systems.

Cost mutualisation is other challenge of implementing the new technology says Morgan Stanley (2016). Building the new software is expensive, and the cost allocation between participants might be difficult. An investment to the new technology made by a financial institution might enable free riders. One solution to the question is an infrastructure built by a third party, for example a consortium of banks like the R3. The financial industry has traditionally been characterized by independent players, and the cooperation has been mostly driven by legislation. To achieve the benefits provided by a shared, transparent ledger, cooperation is necessary.

At the moment there’s several different ways to technically execute the blockchain/distributed ledger technology and it’s difficult to predict which one(s) will be the dominant standards, which of course exposes the players to the risk of investing in wrong technology. Goldman Sachs, among other reported the risk of failing to form universal standards, a major hurdle in adopting blockchains in financial markets.

Also Mori (2016) points out the significance of cooperation in implementing the blockchain technology. For example, the transaction of securities, one major use case for the blockchains, is a complicated process with stakeholders including central banks and financial services agencies as well as financial institutions, issuing firms, exchanges, securities settlement systems, transfer agents and those parties trading on behalf of investors and brokers. All these stakeholders should be included in pilot studies in order to change the market practices and the law. The cooperation between private and public sectors is vital for the successful deployment of blockchain technology into financial markets.

When a the blockchain technology is used, it has to be integrated with existing banking processes initially and therefore many system integration and scalability issues will be encountered. (Blower et al 2016)

Morgan Stanley (2016) also points out the scalability issues as a one significant problem that has to be considered when developing the new blockchain/distributed ledger technology. For example, in Bitcoin the scalability issues have already become evident, or at least well anticipated. Four examples of circumstances where scalability problems arise are mentioned. First, the moment when the full blockchain ledger is intended to fully distributed to all participant nodes. Secondly, multiple nodes must agree in order for a transaction to be executed, which might cause problems at some point. Also, all nodes are required to have coincident access to the ledger and transactions, which again might be a problem if the amount of nodes grows high. Fourth, the blocks might appear to be too small to allow for high velocity or frequent transactions, causing transaction recording to overflow the block size. The scalability issues are a widely admitted fact that the existing blockchains have, e.g.(Tschorsch & Scheuermann (2016, p.2101) report this. They are also one major reason why banks have the opinion that blockchain technology should, at least in the first place, be deployed to market segment with relatively low volumes and limited amount of parties involved.

Painelli & Peters (2015) also recognize the same issues, stating that "current blockchain structures, requiring the repetition of computation on all network nodes, will rapidly run into scalability issues, and this will require consideration before mass adoption becomes possible."

Also the Waves white paper (Ivanov 2016, p. 5) shares the view that a decentralized system will not be useful for high-frequency trading, especially because of the latency related in this kind of solutions. They say that probably a centralized system will always remain the most adequate platform to carry out high-volume transactions with milliseconds execution times.

Mori (2016) references to a report of The European Securities and Markets Authority stating that presently it's not easy to retrofit blockchain to an existing system. Mori gives a rough estimate that "only 20 per cent of the barriers to adoption are technology based, the other 80 per cent are attributable to current business processes." Mori also shares the common view that without substantial changes to existing business processes it is unlikely that it would be possible to leverage the full potential of the technology.

The governance of the blockchain/distributed ledger is one concern that financial institutions have according to Goldman Sachs (2016). It's unclear who would be in charge of maintaining and managing the blockchain. Who would admit new participants to the blockchain or who would determine which parties see which transactions? The new participants would have to satisfy the statutes of KYC and AML regulations, but who would be the party carrying out the auditions of the participants?

Morgan Stanley (2016) says that from the view of a financial sector analyst, the distributed ledger technology is just an upgrade to the IT software. This upgrade provides shared, immutable records, which makes processing transactions less error prone and therefore is a logical thing to do. The problem is that there is no "one size fits all" platform. It's likely that there will be different kind of blockchains for different purposes. They say that it´s likely that most of the blockchains will be integrated to the existing infrastructure, but some will require a whole new core interface. Morgan Stanley points out that financial institutions will only be accepting blockchain technology if they deliver hard dollar cost savings within three years. The increased process efficiency is not much use, but instead the technology must provide organizational efficiency.

The security of cryptographic solutions is another concern. Financial markets are hacked intensely and the technology used in the systems must be secure even against state-sponsored terrorism and bugging. The success of the established payment networks, which have made effective use of both improved authentication technologies (EMV), as well as seemingly effective behavioral and historical analytics to keep fraud rates low is encouraging.

5. New Entrants versus Traditional Financial Institutions: Case Lykke

The financial institutions seem to have surprisingly unanimous opinions on what will work in the financial markets when it comes to blockchains. It´s hardly possible to avoid the thought that they are being too self-confident. In this chapter we lay an eye on the smaller players, fintech companies that develop the blockchain technology. There are numerous startups working in this field, with different kind of applications and technical solutions. In this chapter we examine Lykke as an example of a smaller fintech company. In the subsequent part of this chapter we look what the banking industry thinks about the new entrants. In chapter 7, there´s more information of what the fintech companies are doing, as we examine several use cases where they are doing research on.

As we have seen from the various reports by financial institutions and consulting companies, they seem to have a different kind of approach to blockchain/distributed ledger technology than many of the startups. Lykke, a swiss-based company is a good example of a startup with extremely ambitious targets of revolutionizing the financial world with the new technology.

Lykke defines itself to be a "movement to build one global marketplace that is a level playing field where everyone has access." The company has started with foreign exchange and has plans to later expand to other sectors like money markets, bonds, equities and commodities. Lykke says that will be a profitable company with a market share of 0.5% of the FX markets where the daily volume is 4 trillion USD.

Lykke says that it is building a trading venue, where buy and sell orders are crossed with a matching engine. The accounting, delivery and settlement of the traded assets use the distributed ledger technology. They point out that Lykke is not a crypto-currency or distributed ledger technology venture, saying they are building a marketplace that integrates seamlessly with the existing financial system. Lykke will earn its revenue from the transaction volume that passes through its matching engine. Lykke will charge a ticket fee of 10% of average spread. (Lykke.com 2016)

Their vision of the future claims that there will be one global internet exchange, where all financial instruments are traded and exchanged against each other, whatever their asset class or size of transaction. The platform is highly efficient: transactions will be validated and settled immediately and they will be recorded to a distributed ledger that is universally accessible. Lykke's aim is to be this exchange. Lykke compares the distributed ledger to internet as it´s not controlled by any single entity. Instead, it´s an emergent phenomenon consisting of its participants.

Lykke´s platform is structured using the colored coins technology relying on the Bitcoin blockchain. Lykke offers an exchange for these colored coins, and in the beginning it will focus on FX, planning to later broaden the variety of assets traded.

As this makes the functioning of the platform dependent of the functionality of Bitcoin, it´s important to understand the view Lykke has on it.

There´s a great difference in the stance on Bitcoin compared to financial institutions. In their white paper, (2016) Lykke justifies their optimism on Bitcoin by its success in the past. Bitcoin was the first widely adopted implementation of blockchain technology and has strengthened its position over the years. It's becoming more broadly accepted in online and physical stores and its use measured in the amount of transactions per day has increased rapidly. The Lykke paper mentions other cryptocurrencies, like Litecoin and Ethereum having some advantages compared to Bitcoin, but the dominant position that Bitcoin has in the cryptocurrencies markets is seen to remain stable.

The scalability issues of Bitcoin technology aren't seen as a big problem, Lykke is optimistic that the amount of transactions now limited to 500 000 transactions per day will be raised higher once this barrier will be reached. Anyway, as the Lykke exchange is assumably capable of paying higher transaction fees than private users, which ensures that these transactions will be validated, Lykke won't be among the first ones suffering from this limit. The attitude is optimistic, probably a technical solution for this issue will be found before it will become a problem.

Many of the threats involved in the use of a public distributed ledger, the Bitcoin, are identified in the Lykke white paper (2016) but they aren't considered to be that big issues. Lykke admits that the solution of using colored coins isn't perfect by all means, but rather an excellent trade-off between performance and security. This approach is significantly different to the view of traditional financial institutions and regulators, who don´t want to compromise the security of markets at any cost. Of course it´s good to keep in mind that building a 100% secure system practically isn´t possible, and therefore the existing market systems can´t be absolutely secure. Anyhow, they have proved their functionality and stability over decades.

The legal risks, issues pointed out in every single report made by any financial institution or consulting company, haven't gotten that much of space in the Lykke white paper (2016). There´s said to be uncertainty regarding Bitcoin and colored coins. The law-makers might address this uncertainty in the medium run by creating new laws. The paper says that Lykke needs to be aware of the problems and capable of quickly reacting to changes in legal environment. Legal and regulatory risks will be mitigated by ensuring that all blockchain obligations will be replicated in terms and conditions of legal contracts.

There´s not too much said about the KYC/AML issues either. There´s a statement that "regulatory standards will be applied." Lykke says that it´s unclear at which point the KYC rules apply, if all. One reasonable application of laws would be to require the KYC checks at the points the colored coins are issued or redeemed. There´s also several other risks, for example it´s possible that the sale of colored coins could be limited to only professional market participants. There´s really no regulation in the cryptocurrency world and therefore Lykke avoids taking too much stance on where the situation will evolve, even though it has a rather optimistic view on the future success of Bitcoin. In the Lykke white paper (2016) it says that the only way to gain clarity on the regulation is to discuss the open questions with the regulators.

As Lykke points it out, they see that the broad software architecture for operating the exchange does not yield any surprises. They say that there´s still many open questions when going into detail, like how to exactly integrate the service into existing trading environments, but they don´t expect any fundamental obstacles that would prevent them from realizing the architecture as described.

It's clear that Lykke has very contrary views compared to traditional financial institutions on the way the blockchain technology should be implemented to financial markets. Especially the use of permissionless blockchains is an opposite decision to what the banks have made. Their visions are very ambitious, saying that in the future basically everything would be traded on single blockchain that would be maintained by "everyone", in a similar way as internet. This kinds of visions are common within the startup scene.

Lykke has started from offering a market place for FX of virtual and fiat currencies. There are also other online platforms for FX and most probably this kind of traditional services have the best chance to succeed in the first place. Buying other asset classes, like equities, by using cryptocurrencies is a function that might take some time to get developed as it is a more complex procedure in many ways, not the least in legal terms. Sadly, Lykke doesn't comment how well the blockchain would succeed in handling all of the daily $4 trillion FX volume. This would be interesting to hear, as the scalability issues are a clear technical problem that might restrict the development at some point.

In case the technical and legal issues will be solved, Lykke, or other fintech companies might evolve to be a serious threat for the traditional financial institutions. They would lose parts of their business, as there wouldn't anymore in the future be need for intermediaries for trades and transactions, securities holders, or bank accounts. Everything would be stored in blockchains and the new entrants, fintech companies would offer assistant services on this technology to enterprises and individuals.

At the moment it seems difficult to believe that the permissionless systems could fulfill the requirements of legal framework. If this isn't going to happen, key question for Lykke and other startups using permissionless blockchains is how well their platforms can be

adopted into permissioned blockchains. If this can be done easily, they might be in good position in the future as they have already gained lots of expertise and operating knowledge when running and developing their platforms. Also the possibility of central banks issuing digital fiat currencies in the future would be likely to solve many of the problems related to the operating concept of fintech companies.

6. Banks' views on new entrants

To understand why banks should be aware of the threats that the fintech companies using and developing blockchain technology we need to look what have already happened in the past. New entrants have dragged parts of businesses that have traditionally been only playground for banks. This has happened e.g. in payment applications and lending sector. Blockchain companies could, however, be a way bigger threat for banks than the fintech companies now operating in the markets.

UBS (2016) say that they are "not naive about its potential to disrupt our business. Quite the contrary, the more we learn about this technology, the clearer its transformative nature becomes." They share the view that disintermediation of trust could put centralized organizations (banks) in disadvantage.

The reason is, that blockchain could, in theory, eliminate the need even for central banks. As Tschorsch & Scheuermann (2016, p.2086) say it: "So, how can we eliminate the central bank? Bitcoin solves this in a very pragmatic way: in a sense, everyone is the bank. That is, every participant keeps a copy of the record which would classically be stored at the central bank. We can consider it a distributed ledger reflecting all transactions and ownerships. In Bitcoin, the so-called block chain takes the role of this distributed ledger".

While eliminating central banks seems to be quite a non-realistic scenario, as this would probably mean that governments would lose their chances of supervising and controlling the monetary policy, when it comes to commercial banks, this isn't as hypothetic scenario that it might seem in the first place. Because in the future all participants could have a trustful record (via distributed ledger) of e.g. securities, loans, payments etc. there wouldn't be need for similar kind of central party (a bank/other financial institution) to manage the transactions. Probably banks would still have some kind of accessorial services even in the most radical scenarios, but anyhow they could lose several of their current profit pools.

On the other hand, as mentioned before, blockchains could develop into being extremely useful tools with which the banks and other traditional financial institutions could gain huge cost savings and develop new kind of profit pools. The point is that if they don't keep up with the progress and succeed to create superior solutions compared to new entrants, they might as well lose, at least partly, their current positions. As Morgan Stanley (2016) says it:

The blockchain could be a double-edged sword that might disrupt financials. The firms who are holding the keys to data and IT architecture could drag more profit pools towards themselves.

Santander Innoventures identified many use cases in which the new technology could be used. They say that many of these use cases could be solved by using the existing technology. It seems that banking sector, to some point, considers the VC-funded new entrants as a threat, as they can gather the incumbents together to discuss how to deliver more efficiency with reduced costs. The banks are not too interested in having new competitors in their markets, and this might be one driver for them to develop blockchain systems themselves. Blockchain technology might also be a threat for whole traditional banking as it in theory enables the ability to make transactions between parties without the need for the trusted central utilities that currently serve the function of reducing counterparty risk.

Morgan Stanley (2016) says that the markets underestimate the competitive advantage that banks have in creating blockchain based applications for the financial markets. In their report, Morgan Stanley highlights the significance of client relationships the banks have and says that if the banks can offer a more streamlined process with lower costs, they have a competitive edge against new entrants. They also point out that tech companies might not be eager to vertically integrate into a regulated financial institution through the new technology. Instead Morgan Stanley thinks that it's more likely that they want to retain their tech-oriented multiple as a supplier of software and consultants to the banking industry.

Their view is that due to this kind of jurisdictional and other limitations, a system developed by banks and other financial institutions is more likely to succeed than a system developed by a VC sponsored start-up. Anyhow they also point out that since there are no clear jurisdictional statements considering the new technology, anything can happen in the future. The new technology might offer opportunities that are difficult to imagine at the moment, and Morgan Stanley admits that they might be wrong with their predictions.

The new technology could lead to a situation where basically all the transactions are programmed to the ledger and executed automatically. This can be seen as a risk for the banking industry as the tasks of the custodians would be limited to identification of the final investors and issuers and controlling their access to the distributed ledger.

Accenture (2015) sees that most importantly, it's vital to have a clear focus on the most potential use cases of the technology, and during the research to focus on cases that have the greatest benefits, cost savings etc. It´s important to see what solutions create real value and avoid wasting resources on inventing the Bitcoin again.

Banks should invest in educating their IT and business staff to the distributed ledger technology, but also to acquire startups in this sector, as they have lots of expertize and in creating digital solutions. The banks should start building capacity in an agile way so that they have the resources ready if and when the technology succeeds. It's important to monitor what the regulators are doing and have an eye on the startup scene, following what kind of solutions they create. These solutions should then be tested and adopted or dropped as their potential gets examined during the testing. It's also important to discuss with the clients what kind of solutions they desire in the future.

For example, Nordea has made this kind conclusion, and as Finextra.com (2016) news article reveals, they have e.g. created a programme for selected startups to develop their ideas alongside Nordea and technology partners IBM, Tata Consultancy Services and programme facilitator Nestholma. Nordea representative Jan Sirich says that they rely on acquiring expertize and creativity outside their own organization as well.

This kind of movements signal that the banks and other financial institutions themselves aren't that capable of creating superior blockchain-based solutions compared to startups as Morgan Stanley wants to claim in their report. The startups might be able to create something big, whereas it's definitely true that at this point the banks are in good position as they are in position where the startups want to cooperate with them and the banks can acquire them easily.

It's also possible that banks are slowly changing their view on Bitcoin and other cryptocurrencies as well. Earlier Rasmus Järborg, Chief Strategy Officer of the Scandinavian bank SEB said: "We have had a very conservative approach towards Bitcoin. It is the underlying technology that is interesting. It can delete all steps in a share purchase and ensure that everything is done immediately ". (exmo.com) This opinion is exactly in line with the opinions that banks have had on blockchains and permissionless blockchains.

However, very recently, in the beginning of August 2016, SEB invested $4 million in the blockchain payment provider Coinify. In the press release (Coinify.com 2016) David Sonnek, Head of SEB Venture Capital says: *"Coinify has developed a unique platform for blockchain payments and fits perfectly in our portfolio of FinTech investments. We at SEB Venture Capital really look forward to contribute to Coinify's future development,"*

Coinify is a startup offering trade and exchange services of digital currencies to fiat. A significant part of its operations is the payment services that they provide for enterprises. They offer an easy ready-to-go solution with which an enterprise can start accepting payments in cryprocurrencies, which the Coinify platform then automatically exchanges and accounts to the bank account of the enterprise in fiat.

This might be a sign of two different things. One option is that SEB has become more confident on the success of cryptocurrencies at least in payment systems. Other, a more skeptical, or possibly realistic option is, that they have become convinced of the expertize Coinify has on the blockchain technology and see that they can utilize this knowledge in developing blockchain-systems that are more suitable to financial markets. The fact that there is a fair chance that cryptocurrency payments will gain a broader proportion of the payment in the future is a bonus, as they now are involved in this area as well.

The Utility Settlement Coin (USC) is one example of how the banking industry tries to create a dominant virtual currency for the financial markets. The USC is being developed by four banks, BNY Mellon, Deutsche Bank, Santander and UBS, together with markets operator ICAP and Clearmatics, a startup creating blockchain-based clearing machines for OTC-markets. The USC is a series of cash assets, with a version for each of the major currencies. The USC is convertible at parity with a bank deposit in the corresponding currency and is fully backed by cash assets held at a central bank. Spending a USC will be spending its paired real-world currency. The idea is that the pay leg of e.g. equity trades could be performed using USC, leading to cost reductions and increased speed of transactions. (DB.com 2016)

The USC is a very recent project, DB, BNY Mellon, Santander and ICAP joined the project on August 24th 2016, while UBS and Clearmatics had started the project a year earlier. It's another clear sign of how important the collaboration with startups is for the traditional institutions when developing new blockchain-based solutions.

Banks have very different views of the way the blockchain should be deployed into financial world than many fintech startups. In general, the banking sector is unanimous that a permissioned system is the only possible option whereas most of the fintech companies seem to focus on creating applications based on permissionless blockchains like Bitcoin and Ethereum. The views on which markets the blockchain should be deployed are similarly contrary. Banks see that the new technology should be implemented (at least in the first place) in markets with relatively low volumes and limited amount of participants. This is justified especially with the scalability issues of existing blockchains. Many of the fintech companies, on their half, aren't that restricted in their approach, and see that blockchains have the potential to revolutionize all kinds of markets. They seem to have the view that technical development in the future will solve the issues.

Anyhow, the traditional institutions have recognized their vulnerability and the possibility that new entrants might drag their current business for themselves. They have also admitted that the fintech companies have much of expertize in this field, and in order to keep up with the development and secure their positions, the banking industry has started to develop blockchain platforms together. If banks succeed in building a functioning

platform, the barriers for new entrants to take over the industry is significantly higher. Banks have started making acquisitions on promising startups, and utilize their expertise in order to build interbank blockchain platforms.

7. The view of regulators

The jurisdictional issues that remain unanswered are seen as a major threat and challenge for implementing the blockchain technology to financial markets. No matter what is the use case, the same questions seem to pop up when it comes to regulation. Therefore it's important to monitor the regulators' opinions on the technology. In this chapter we discuss what is happening in the U.S., the biggest market in the world.

7.1 Federal Reserve

The governments have, at least to some extent, admitted the potential of the blockchain/distributed ledger technology. Brainard (2016) report gives an insight to what's happening in the Federal Reserve. They are not blind to the possibilities of new technology. In 19th century the telegraph improved communication and the railways did the same for transportation. More recently, in the 1960's, computer based financial markets seemed to be only a daydream of technology fanatics, but during the next decade the computer technology revolutionized trading. FED sees that similar steps in technical development are likely to happen also in the future even though today it might be difficult to imagine such revolutionary innovations. FED is not saying that the blockchain will be the next big thing or take any view on how probable its diffusion is. What they say is that blockchain might revolutionize the markets in a similar way that other technical solutions have done in the past. They are taking it seriously.

FED points out that the blockchain/distributed ledger technology might be useful especially in settlement and clearing procedures. The clearing houses, built for coordination of settlement and clearing, have played a major role in the markets since the first clearing house was founded in New York in the 1850´s. Multilateral clearing was used early on and after the recent financial crisis, there has been intentions to shift more and more towards centralized clearing especially in the derivatives markets, where bilateral clearing has been widely used.

The distributed ledger would radically change this situation, as the transparency of records and instant clearing processes that it enables would eliminate lot of frictions that the multilateral system causes due to its nature. All the participants would have a shared history of all the transactions in the system. The ownership and availability of an asset for a transfer would be visible to all parties. Especially in cross-border transactions the faster processing and reduced costs would be a significant improvement. FED sees that the new technology might be an efficient solution to the problems that the derivatives clearing has. Also the advantages of self-executing smart contracts are pointed out.

FED shares the view that there are still several technical challenges to be addressed for a widespread adoption of the blockchain technology to be possible. The legal framework is one question, but the legislation can adopt to new technology. Clear standards for the technology and interoperability between different systems are vital for the technology to achieve its full potential. The distributed ledgers must compete with other options that the financial markets have in this highly regulated field. Also the governance of trading systems must be clear, so that there will be clear roadmap to follow in case that an adverse scenario in the system occurs.

The stability and functionality, which in the current systems is on a good level can´t be compromised at any cost. No matter what the technology is being used, if the risks of the clearing and settlement are not identified and taken into account, the market functioning might be impaired as the participants of the market won´t be able to manage their obligations. This is a major reason why the markets are so regulated and any new technology entering the industry must ensure high level of security and stability. **In a traditional business case the most efficient technology will be likely to end up to be the choice, but when talking about coordinated industry-wide systems, the outcome isn't as clear.** There has to be a wide public interest towards the system to become a new standard.

FED points out that there are also some markets or segments in which the clearing processes are more cumbersome and outmoded, and in these kind of markets the network hurdles to the adoption of new technology are lower. The improvements in this kind of smaller markets would be an opportunity for market participants to gain operational and business experience with the new technology and later lead to its expansion to wider markets.

FED sees that today's clearing houses are well positioned to evaluate the new technology and will likely remain to be major players also in the future. They have invested big amounts to their systems that build up a trusted and functioning network in the markets. FED says that they are likely to provide the core infrastructure also in the future. However, if the distributed ledgers evolve and prove to be useful tools in the clearing processes, the clearing houses will need to keep up with the technical development and update their infrastructure at least in some asset classes. Moreover, they have to tune their systems to work together with the new market segments that, in the view of FED, could be the most potential use cases for the blockchain technology. FED sees the highest potential in controlled, permissioned distributed ledgers. The data sharing and controlling access rights is easiest to carry out in these kinds of systems. The view of FED is similar to the stands that major financial institutions have taken towards the blockchain/distributed ledger technology.

FED says that it will remain to follow the regulatory issues that the new technology arouses with a great interest. It seems that they don´t want to be a barrier for the adoption of blockchain, but want to cooperate with the parties involved to enable the development and take care of the security and stability of the potential new systems. Finally, FED points out the significance of trust and confidence in the trading system and between the market participants to be the most important issue in the markets and sees protecting these elements as its mission in the evolving environment.

7.2 The U.S. government

The US government has been a bit slower in its movements, but the technology has got attention there as well. One example is a recent resolution submitted to the House of Representatives. The resolution (US Congress, 2016) talks about several technological challenges and opportunities foreseen in the future. It says that the US should adopt a national policy for technology to promote consumers' access to financial tools and describes the existing payment system provided by traditional financial institutions to be "decades old". It encourages the government to act towards enabling emerging payment systems, and alternative non-fiat currencies are mentioned as an option to improve the situation.

Moreover, it says that the government should monitor whether the blockchain technology has the potential to "fundamentally change the manner in which trust and security are established in online transactions through various potential applications in sectors including financial services, payments, health care, energy, property management and intellectual property management". These kind of statements are strong signs that there´s likely to be more outcomes from the governments in the future to enable the adoption of the new technology.

8. Potential use cases

The purpose of this chapter is to give an overview of situations where the blockchain/distributed ledger technology could be implemented. These are use cases that have either been under discussion or already have some kind of "beta" application in public use. It's good to keep in mind that so far Bitcoin is the only blockchain-based solution that has gained a wide adoption. The potential of the technology is huge and it can be applied to several different kinds of uses in the financial world. This chapter presents nine different use cases that give the reader an overview of these possibilities. They definitely aren't the only possible use cases, but rather topics that seem to pop up in the discussions most often. In the future there might evolve applications that no one can predict today.

On the other hand, in addition to demonstrating potential use cases, this chapter speculates on how the new technology might change the competitional environment in the financial markets. This field has been dominated by banks, but the fintech companies developing the blockchain technology might pose a threat to the traditional financial institutions.

8.1 Identity management and digital signatures in Estonia

Estonia is probably so far the most developed example of how the blockchain technology can be used in a national level. Estonia has taken big steps in blockchain utilization and as a result they now have the most regularly used Public Key Infrastructure in the world. This infrastructure is provided by Guardtime, an Estonian-based company now headquartered in Amsterdam. By using their private keys, Estonian citizens or companies can utilize this infrastructure to authenticate digital signatures. This system is used for several operations, the Estonians utilize it in voting, banking services, reviewing their children's school records, applying for state funds or to serve in military, filing their tax return and so on. There's around 3000 functions in the system at the moment. The companies can use it to file their annual reports, issue shareholder documents, apply for licenses, etc. Government officials, in turn, use the system to encrypt documents for secure communication, to review and approve permits, contracts and applications, and to submit information requests to law enforcement agencies. Ministers even use it to prepare for and conduct cabinet meetings, allowing them to review agendas, submit positions and objections, and review minutes.

The citizens and companies are issued the ID card, which acts as a private key. The system is colored coin –based and the ID card uses a hash function for login. Estonia has succeeded in the possibly most vital feature of the system; it is very user-friendly. Over 200 million digital signatures (39 per capita) made using the system is a strong evidence

of its functionality. The user doesn't have to know anything about hash functions, colored coins or the blockchain, the technology acts in the background enabling familiar applications, like a payment app.

The blockchain/distributed ledger technology enables an exact and reliable record of all digital signatures carried out. The ledger is visible to the parties involved. It´s important to the government to have reliable and up-to-date records. From the citizens point of view, the technology improves the legal protection, as the individuals are able to keep track on who has viewed their data, why and when. All alterations to one's data have to be authorized, which reduces the risk of tampering data. The technology is also very scalable, being able to sign an exabyte of data per second. User privacy is also secured as the system works only one-way. In other words, it isn't possible to start with the encrypted data and reverse engineer it to customer data. It isn´t immune to attacks, but ensures that all corrupted alterations made to the data are completely detectable.

The Guardtime platform is structured in such a way that it has self-defence against remote attacks. It monitors the executable code during run-time, and if the code is unsigned, it will not be executed. It also reports the suspicious alterations to the code automatically.

The system has great potential to evolve into an even more important part of the society, but this requires that jurisdiction on the distributed ledger systems keeps up with the development of the technology. Too strict legislation will ruin the opportunities of the technology, but on the other hand, the lack of clear jurisdiction can cause misunderstandments and suspicions about the technology, which could be similarly harmful to its development. Its success in Estonia has aroused interest in other countries as well, and at the moment Guardtime is working with the authorities in United States to develop a platform able to handle real-time authentication and monitoring for all digital assets, including firmware, software, configurations, data stores and event logs in compliance with regulatory risk management framework guidance. (GOS 2016, Guardtime.com 2016)

8.2 Post-trade settlement

Settlement and clearing might have slightly different meanings in different markets and countries, but clearing typically typically involves post-trade operations, such as trade matching, confirmation, registration, as well as risk-management functions, such as netting, collateralization, and procedures (including "variation settlement" or "variation margin") that mitigate or eliminate some forms of credit risk. Settlement, by contrast, involves the transfer of money or assets necessary for the counterparties to their obligations. The clearing and settlement systems are vital for financial markets. (Bliss & Steigerweld 2006)

Morgan Stanley (2016) found out that post-trade settlement was one of the use cases of blockchain/distributed ledger technology that came up most frequently in discussions with the banking industry. This includes several assets classes like corporate loans, CDS, repo, derivatives, equities etc. Blockchain technology can be especially useful in asset classes with the least efficient netting, clearing, collateral management and long settlement periods. Post-trade settlement is interesting use case because it's costly and therefore the new technology could bring up significant cost savings. The process is complex, with each transacting party having its own controllers, as well as internal and external auditors and ultimately regulators viewing the transactions. Misalignments aren't rare and these cause extra costs as more people are required to be participated and the delays tie up capital and liquidity. The distributed ledger would ensure that all parties have the same, official record of the transactions, which would decrease the potential of misunderstandings and make the process faster.

Goldman Sachs (2016) sees that transaction costs are relatively low for securities such as equities, but says that up to 10% of trades trades are subject to various errors, leading to manual intervention and extending the time required to settle trades. They say that by applying blockchain to the clearing and settlement of cash securities – specifically, equities, repo, and leveraged loans the industry could save $11 - $12 billion in fees. They say that blockchain could also potentially eliminate significant additional costs across FX, commodities, and OTC derivatives.

Corporate whole loans trades are an example of lengthy settlement procedures, with typical settlement periods of 2-3 weeks. Especially the review process takes time which lead to increased costs and might expose the parties to market risk and limited liquidity. Distributed ledger might speed up this process, as all the parties involved could see who is viewing the documents and for how long, this could push the intermediaries for faster processing.

Blockchain/distributed ledger technology could also shorten the settlement window, which at the moment is typically T+2 or T+3 days. This is linked with the legislation, but the technical improvement is pushing people to expect faster response times. As Blythe Masters, CEO of Digital Assets Holdings said, *"It should be ironic to all of you that trading infrastructure has evolved to the point that competitive advantages are measured in fractions of nanoseconds and yet we're still dealing with T plus two, three or worse, depending on your asset class."*

Morgan Stanley (2016) points out that in many asset classes the T+0 settlement could be executed by the existing technology if the legislation would allow to do so. Also the markets with T+0 settlement today seem to have less liquidity and more volatility than the markets with longer settlement periods. This is explained by many factors, especially the fact that there is no possibility for shorting in T+0 settlement markets, which reduces

the liquidity. The shorter settlement period will free up capital but also decrease the profits of lenders. Morgan Stanley's view is that the settlement period will shorten in the future due to legal and regulatory issues, but they don't see it going down to T+0. The profit gained from the carry is one reason why the banks are not too eager to apply the new, more efficient technology. The profit made from carry helps to cover the costs of the expensive and less efficient system. But if the cost reductions gained from the new technology are greater than these profits that will be lost, the banks will change to the new system quickly.

Also the ECB (Pinna & Ruttenberg 2016, p. 26) agrees that T+0 settlement could be implemented by using the existing technology. It sees that the benefits of instant settlement could be achieved by implementing a whole new environment for the settlements. At the moment it would be unfeasible to implement a T+0 system globally for the vast amount of transactions taking place, while the business processes and databases remain as they are. The ECB's view about the diminishing impact of instant settlement on liquidity isn´t as opinionated as Morgan Stanley's. The ECB sees that this matter has to be assessed. T+0 settlement would eliminate the credit and liquidity risks from the trades as they would be carried out instantly. (Pinna & Ruttenberg 2016, p.26)

Morgan Stanley (2016) says that the blockchain/distributed ledger technology would also be used **to hold reference data for individual securities**. A rules-based data stored in the blockchain could enchance quality and auditability when transactions occur. There would also be efficiencies in the regulatory field, as both the banks and regulators could use the transparent distributed ledger in their regulation.

8.3 Derivatives markets

Derivatives market is one relative use case of the blockchain/distributed ledger technology. This market's value is as large as the US GDP or the global bond market. Credit risk exists especially in the OTC derivatives, which form a dominant part of the market. Especially after the crisis of 2008 and the fall of Lehman Brothers there has been a dramatic change in the market, moving from high leveraged, complex payoffs system with a little attention to risk management into a world of heavy regulation, standardization and big awareness of risks. The funds and corporations have become increasingly unhappy with the derivatives market in which the prices of the products are not related with the intrinsic market risks.

The regulation has made the markets safer but has led to higher costs as financial institutions have to meet the new standards. These include e.g. Credit Value Adjustment, adjustment made for handling the default risk of banks' counterparties, Funding Value Adjustment, adjustment for the cost of funding banks and Capital Value Adjustment, an adjustment for the extra-capital that banks have to hold to contrast the increased default

risk, among many others. The derivatives are still crucial for many parties in hedging their risks, but these regulations have meant a sharp cost increase. (Morini 2016, p.6)

It is possible to reduce this kind of charges through collateralization, but the efficient execution of the process is not easy. Derivatives users typically lack the expertise and infrastructure necessary to move securities and cash quickly. Variation margin is typically updated every fortnight and only if cash needed to transfer is above a certain threshold. This leaves the counterparty exposed to some risk. Even daily settlements won't match the exposures completely and also the models used to compute collateral exposures might variate between the counterparties, leading to misalignments. Capital costs, for their part, can be reduced by using central parties, but this creates a compression of systematic credit risk. The result is, that the central parties are over-collateralized compared to standard counterparties.

Traditionally, in derivatives markets the use of central counterparties (CCPs) have been a common practice outside the OTC-markets. There are several reasons why CCPs are being used. Perhaps the most important reason is the homogenization of credit risk and the structure of mutualized loss sharing that facilitate anonymous trading between the participants. In bilaterally cleared markets, the counterparty risk is always present and influence the decisions on which counterparties will trade with each other. In a centrally cleared market all the market participants are treated the same way. (Bliss & Steigerwald 2006) As we will find out soon, the blochchain technology can dramatically change this situation. Counterparty risk might be eliminated from bilateral clearing, leading the OTC-markets being as safe as centrally cleared markets.

Smart derivative contracts are the thing that could revolutionize the derivatives markets. This kind of smart contracts would be able to value itself in real time, calculate and perform margin payments automatically or terminate themselves in a case of a counterparty default. As the smart contracts would be written in a Turing-complete language, they could handle any kind of derivative from the plain vanilla ones to the most exotic ones.

For example, a simple call option could be executed by a smart contract that would instruct the network to transfer

$\max (S_T - K, 0)$

from Party A to Party B at time T. The S_t value would be provided real-time to the smart contract by a trusted data provider, and the contract would take care of transferring the right amount of money automatically. The smart contract would handle the collateral management the right amount of collateral would be transferred between the parties frequently. This could be done several times a day. This would dramatically decrease the credit risk between the counterparties leading to decreased amount of initial margin.

The derivatives' payoffs and prices are calculated by using mathematical software. This process would be integrated to the smart contract. It is necessary for the counterparties to agree on a model of valuation and collateral as they enter the contract. This will eliminate many of the challenges that exist in the OTC markets as it leads to the collateral being exact, real time guarantee of the contract. Even better, in case of a counterparty default, the closeout process of the contract will become much faster and eliminate the need of several third party involvements in the process. The close-out amount would be calculated by the network and the gap between the collateral and close-out amount would be minimal due to the high frequency calculation model.

The contract could be structured in a way that a failure to fulfill the contract wouldn´t have to be a default in legal terms. If there is a shortage in the collateral update, the contract would be terminated in few minutes after the previous full collateral payment, and as the gap between the exposure and the amount of collateral would be small, the counterparty wouldn't suffer high losses due to the failure of the other party to fulfill the terms of the contract. The complexities of a legal default process would be avoided.

The bilateral agreement on valuation model of a derivative contract would also lead to derivate contracts that better fulfill the needs of the derivative users. At the moment, many market participants are forced to use a standardized, only option defined by a clearing house. This kind of one-size-fits-all model is much more restrictive than the bilateral model, where two parties would agree on the contract pricing and the collateral exchange during the contract's maturity time.

The lack of interoperability between centralized database systems restricts straight through processing of several non-vertically integrated financial institutions. The need to reconcile accounts kept by different intermediaries creates certain risks, such as chains of settlement failures (as delayed settlement of one transaction may affect the settlement of trades with third parties), human errors (the system sometimes being reconciled manually), and limited collateral fluidity. Additionally it leads to widening the settlement cycle and increasing the cost of back-office procedures.

The implementation of blockchain/distributed ledger technology in the derivatives markets requires a whole new kind of trading system. The network system network has to have a consensus algorithm and legally verified nodes, which could for example be members of a new decentralized clearing network. There has to be changes in jurisdiction to achieve this. Morini & Sams (2015)

8.4 Digital fiat currencies

Morini (2016, p. 11) says that the legal status for the technology might come earlier than expected if the benefits of the new technology are noticed by regulators. The system will

also need a digital representation of money. This presentation can be an independent cryptocurrency, a digital currency that is fully convertible in the central banking system, or currency issued by a commercial bank. A central bank –based currency would be the best option, but it would require high-level reformation in the system, and therefore it might not be as quickly as the other alternatives. The other two options have their limitations, as the cryptocurrencies at least in the past have been rather volatile and a currency issued by an individual bank has its risks.

The circumstances in the blockchain/distributed ledger scene evolve at a high pace. In April 2016 the ECB said in their report (Pinna & Ruttenberg 2016, p.24) that so far the market players have paid a little attention to the bridge between technologies used in the securitites leg and cash leg of a trade. The market participants are willing to receive their payments in real-world money rather than a virtual currency. A digital currency could probably be used, but at that scenario an extra intermediary would be necessary to change the virtual currency to fiat. Also the volatility and other risks related to cryptocurrencies would be present.

The ECB sees a virtual currency issued by a commercial bank the most probable option when talking about a trusted option for cryptocurrencies. This kind of system has, of course, a significant risk as the central party of the system would be a private institution. Bankruptcy of the central party would mean losses to the users of the currency. ECB said in April 2016 (Pinna & Ruttenberg 2016, p.24) that it is impossible to predict whether central bank money will ever be available in distributed ledger.

In June 2016 the word spread out that the Bank of Canada is, in collaboration with the R3 organization formed by commercial banks, working on a proof-of-concept experiment on a central bank issued virtual currency, the CAD-coin. The target is to enable the issue, transfer and settlement of central bank assets on a distributed ledger. The Bank of Canada points out however, that the project is just an experiment and that it’s not trying to develop a currency for individual users. (FT 2016) These kind of news are clear signs that the wide-spread use of blockchain/distributed ledger technology might become reality sooner than expected.

The issuance of a digital fiat currency could radically enhance the payments sector as well. In addition to the fact that it would probably solve several hurdles in the institutional world, it could also radically change the payment solutions created for individuals. Digital currency would facilitate the development of different kinds of applications made to the general public. A virtual currency issued by a central bank could make it possible for customers to deposit their money directly to a central bank without the need of commercial banks as intermediaries says Financial Times. (FT 2016)

Accenture (2015) says that “Fedcoin” has been discussed openly by central banks including the US Federal Reserve and The Bank of England. Also Mori (2016) confirms that The Bank of England, as well as the Central Banks of Netherlands and Australia, and The People’s Bank of China are investigating the potential of a blockchain-based currency. If this kind of central bank issued cryptocurrencies become reality, it´s easy to see evolution of many kind of colored coins using the sidechains of these “Fedcoins”. There´s various use cases for these colored coins. For example, they could be used for managing the allocation, sale and resale of tickets (sporting events, concerts etc.), enabling a market in the tickets but preventing them from being resold at excessive prices by ticket touts. Other use cases are managing and monitoring the disbursement of charity donations, registering wallet addresses and identity information to facilitate authentication of counterparties for identity, KYC, AML and sanctions checks and distributed interbank settlement for real-time payment clearing systems. Also Centers & Fanning (2016, p. 57) see the potential of blockchain technology for vendors of tickets.

Swan (2016) predicts that the Internet of Things will comprise 26 billion devices and a $1.9 trillion economy by 2020. A virtual currency, “Internet of Money” is necessary in order to utilize the whole potential of IOT. This would enable machine-to-machine payments, and therefore open whole new business models. This kind of automated payments could be used for example in road tolls or air delivery drones. A currency needed for this kind of system would be likely to have some kind of legal status, and from this viewpoint, a central bank issued virtual currency could be the most practical option. It’s possible that at some point the governments realize that in case they don’t issue an official cryptocurrency, the markets might develop their own solutions, that from the regulational view aren’t so easy to supervise. This might be one driver for digital fiat currency development.

8.5 Case LHV Pank & Cuber

LHV Pank, the biggest bank of Estonia, was the first bank to introduce its own cryptocurrency to markets in 2015. This was done in cooperation with Chromaway, a Swedish blockchain technology company founded in 2012. LHV released programmable money worth of 100 000 euros. These are cryptographically protected certificates of deposits. In practice, they are virtual euros backed up by the bank. The digital money can be used and exchanged to fiat euros by using LHV services. As a transfer of the cryptocurrency is a representation of fiat currency against the LHV Pank, it can be used for payments. The merchant has to approve the payment method just like they have to do for credit cards. The system is compatible with POS terminals and cashier systems.

By using the mobile app, Cuber, the customer can transfer money to his mobile phone. The customer can transfer money to other users of the application or pay in a shop/restaurant etc. as long as the merchant is using the same mobile application. The

consumer benefits of the easy payment and avoids the need of using cash or credit cards, as the smart phone is everything that is needed. Fast transactions compared to traditional banking are also strength of the new technology. The merchant side also benefits from the low cost of receiving electric payments. The cryptocurrency may also be used in machine-to-machine transactions, which opens potential use cases when the Internet of Things evolves.

The Cuber system is based on colored coins, so it has the same risks and challenges as other applications using the Bitcoin ledger, such as the BTC price volatility and the risk of rising transaction fees in the future. The system is open source, which means that the application program interface is available to third parties online. This enables e.g. the application to be modified to the individual needs of each merchant. It also enables other cryptocurrency exchanges and developers to use the technology.

The Cuber platform is still only a pilot project of LHV Pank and there's no certainty about how the story will continue. The fact that Cuber is backed up by a bank gives it certain advantages against other online payment systems. The Cuber is still a security – the foundation of bank trading, only with a decentralized bookkeeping. The customer confidence on Cuber is likely to be significantly higher than on other cryptocurrencies. Also the transfer of funds from the bank account is faster than in non-bank based online payment systems.

There are also disadvantages in being a bank, though. Other online payment systems only need a quick online sign-up whereas the banks, including the Cuber system face the tight KYC rules that require a face-to-face meeting in order to create a banks account. The unsolved legal issues remain the biggest risk for Cuber.

(GOS 2016, p. 81-82, cuber.ee 2016)

8.6 Know-Your-Customer/Vendor

As the Deloitte report (2016) states, the KYC processes are typically expensive and additionally they might delay the transactions, as it might take 30 to 50 days to complete the process. In addition to the compliance costs being high, there are also high penalties for failing to follow the KYC guidelines. The amount of KYC-related penalties in the US has been rising the past years and reached their record in 2015.

The distributed ledger technology could offer huge improvements in efficiency also in the KYC sector. Goldman Sachs (2016) predicts that the technology could generate $3-$5 billion in cost savings. All members of the distributed ledger would have the access to view the KYC checks performed by other members. This would eliminate the need to perform duplicate KYC checks on the customers. A member of the distributed ledger system could simply rely on a check made by other member. Actually, already at the

moment there is movement towards sharing the customer information. For example, SWIFT recently established a KYC Registry where banks can share their KYC documentation. Anyhow only around 16 percent, or 1125 banks of the total 7000 banks being SWIFT members have joined the registry. (Deloitte 2016)

Goldman Sachs (2016) says that the blockchain could help the "reputation management" in many applications, like Uber and Airbnb. The data of the users of the applications would be stored in a transparent and tamper-proof ledger. Goldman sees that this could increase the ease of use and security of the users, driving accelerated adoption of these kind of applications. The applications could have a shared ledger, so therefore a user of one application would have a reputation "ready" when the he starts to use another application. Also the payment processing would become faster and more secure. Goldman Sachs sees that the blockchain could therefore have a large impact on e.g. the hotel business as it says that the new technology would increase the use of p2p-lodging services in the future. These kind of visions have to be critically viewed though, as it's not sure in any way that the different applications are willing to share their user reputation data with others. For example in the case of Airbnb, it seems pretty clear that in case they start sharing their customer reputation data for others, it would lower the barrier of market entrance for their competitors. Anyhow, blockchain might very probably have some kind of role in the development of these applications, one clear sign of this is that Airbnb completed the acquisition of ChangeCoin, a blockchain technology company in April 2016.

The blockchain/distributed ledger technology could offer new possibilities that are not reachable using the current technology. The new technology could make the processes automated and thus reduce compliance errors. The updates in customers' records would be delivered real-time to all members of the blockchain. The transparent distributed ledger would also contain the historical record of the shared documents and compliance activities undertaken for each customer. The distributed ledger would also be evidence that a bank has acted by the KYC rules, as also the regulators could have access to the ledger. The distributed ledger would also make frauds more difficult to carry out, as corrupted information would be likely to be detected by some other member of the blockchain system.

As Deloitte (2016) says, the blockchain/distributed ledger technology is often seen as something that enables anonymity of transactions and the players involved. Actually, if the members of a blockchain are known, the technology can be used to create cryptographic identities for these real-world identities. The technology offers businesses, for example banks, the possibility to scan customer documents and identity information and generate the public and private keys to seal them before the information is encrypted and sent to the blockchain. As it's probable that financial institutions will start to utilize the blockchain/distributed ledger technology in other fields that require identification of

the blockchain members, it's likely that some parts of the KYC and other blockchains could be connected to share the information needed for identification.

Naturally, there are some issues in implementing this kind of distributed ledger technology in the KYC checks. As all the members of the ledger would benefit from a KYC check made by one member, the system could allow free riders. The checks are expensive to carry out and therefore there might not be initiatives for a member to perform this kind of checks. It might be possible, for example, that the members could achieve a consensus of compensation that the users of the KYC information would pay to the member that has carried out the KYC check.

There might also be problems in case the KYC information is corrupted. Who would be held in charge in this kind of situation, the member(s) who has used the wrong information or the member who has performed the faulty KYC check? Increased liabilities would probably decrease the eagerness of the members to share their KYC documents. One option is that in the future a central party would be formed to carry out the KYC checks. The members of the distributed ledger could have their representation in this central party and the costs of the KYC checks would be shared by the blockchain members e.g. based on how much each of the members utilize this information.

Also Tarja Grönroos (2016) from Nordea Trade Finance pointed out the KYC process as one potential use case of the and the new technology could offer great savings for the financial institutions. She pushed the idea way further though, and said that the client itself could be held responsible for submitting the necessary documents and information for the KYC process to the blockchain. This KYC information would be available to all counterparties of the client, and eliminate the need of KYC processes performed by the financial institutions.

PwC has some similar kind of ideas on evolution of the KYC process. In future it could be possible that even a wealthy individual could send their passport and other documents to PwC who would then perform a check on who the person is and then transform his records to encrypted form and send them to the blockchain. Later the person could simply prove his identity and creditworthiness by referring to these documents. This would eliminate the need for further checks performed by other parties. Later this identity management could be taken even to a higher level, for example by using fingerprint detection technology the individual could easily log in to different kinds of applications.

Of course this kind of approach would have some challenges as well, for example if the creditworthiness of the individual would later reduce, the faulty information might stay in the blockchain in case it doesn't get updated. Also there's a question about privacy, individuals might not be too eager to share their fingerprints and documents into a

blockchain of which they can't be sure will be used only for purposes that the individual wishes. (FT 2015)

This kind of system would significantly reduce the costs and liabilities of financial institutions. However, this would require changes on jurisdiction, as the responsibility would be transferred from the financial institutions to the clients. There would also be problems with regulation, as there would have to be some party to supervise the reliability of the KYC information provided by the client itself. Anyhow, also this kind of system might evolve in the future, if the regulators see the benefits of the system.

8.7 Trade Finance

Trade finance provides the security and funds the companies need to be able to buy and sell products domestically and internationally. In trade finance the banks give value-adding service to companies by securing the funding for the production or purchase of the goods, helping the businesses in optimizing working capital and by providing payment guarantees. The banks mitigate risks e.g. by providing credit ratings and ensuring the compliance with KYC, AML and other regulations.

The regulations change continuously in different countries and the trade finance services provided by banks ensure that the jurisdiction is being followed. Even though the open-account trading has become more common, making up about 90% of global trade, especially because internet has enabled better communication and exchange of information, there´s still lot of demand for bank services for financing, risk mitigation, data transfer and matching. The trade finance services provided by banks reduce e.g. the counterparty risk, the complexity of complying with laws and regulations in multiple jurisdictions, the risk of goods being lost or damaged in transit, and foreign exchange risk. (EBA 2016, p.6)

8.7.1 Utilizing Blockchains in Trade Finance

Barclays (2016) compares the impacts of blockchains in the trade finance sector to revolutional transforms that have happened in the past. It claims that the blockchain/distributed ledger technology might have as big effects on trade finance as the introduction of factoring that happened during the 16th century or the revolution caused by internet in the mid-1990's.

Morgan Stanley (2016) pointed out that Trade Finance is among the potential use cases that most often pop up when talking about the blockchain/distributed ledger technology. The transfer of goods has to be ensured before the payment is made. This is typically done by using several intermediaries, trade houses etc. By using blockchain all parties involved

could see when the goods are shipped and could release the payments appropriately and make the procedure significantly faster.

Also Finextra (2016, p.12) highlights the potential of blockchain/distrisbuted ledger technology especially in trade finance. It is said to be one of the most suggested area where the new technology could be implied to. It claims, though, that **to make a real difference, the new technology should be adopted by large corporates, the big shippers, manufacturers and customs authorities.** Due to the complex nature of letters of credit and bills of lading used in the business, the blockchain technology would still enable significant advantages, but **the real potential of the system comes from the network effect.**

The Finextra report (2016, p.12) says that in their research with 100 corporates there were only a few who had even heard of blockchain before. The banking industry should promote the technology more to corporates and point out the benefits for them, as it's clear that they won't be willing to adopt an infrastructure if they don't it provides any improvements to the existing situation. There's bad experiences from the past about banks creating new solutions, like the bank payment obligation (BPO), which they think that the corporates will adopt automatically.

Also EBA (2016, p.7) agrees with the view that there has been problems in adoption of the new systems that have been developed for trade finance. There hasn't been a critical mass of corporates and banks supporting the BPO and other instruments and therefore the paper-form documents have remained even in the internet era. Both parties of the trade should be using the same systems in order for them to work efficiently and naturally, as in international trade there's participants from various different countries, this has been a major issue. The different platforms used for different elements of a trade transaction have also made the situation more complicated. A separate system could have been used for financing, other for invoice exchange and third one for ownership documentation. Therefore it's rather safe to say that ensuring that the major participants would adopt a similar blockchain-based system is a major challenge for the implementation of the new technology.

EBA (2016, p. 8) sees that it's not likely that the blockchain technology will replace the existing system. Instead it sees that some banks and corporates will use the blockchain to facilitate the exchange of information, status of the goods etc. while they continue executing the payments via SWIFT or other established networks. It is also possible that different information will be stored in different blockchains. The interoperability between the legacy systems and blockchains is crucial.

The distributed ledger technology gives banks a deeper and broader view of the corporates. The banks will be able to offer more targeted services that suit better the needs

of their clients. As all the participants' transactions are visible, this will make the auditions much more accurate, improving the reliability of credit worthiness assessments. Banks will also be able to price their financing agreements more accurately as they have realistic estimates of the risks associated with different clients. The banks could also be trusted parties that would help the corporates in structuring smart contracts. EBA (2016, p. 8) says that most of the trade finance services offered today are focused on the 10% of global trade done using traditional finance products such as letters of credit, while the distributed ledger technology would give the banks opportunity to target on the 90% of the trade done on open account basis.

The blockchain/distributed ledger technology could help secure the trust between the trading partners by making the transactions and transfers of the products transparent. This would guarantee the reliability of data, make the credit ratings more accurate, facilitate the payments and reduce the risk of frauds and errors. (Pinna & Ruttenberg 2016, p.7)

Trade finance suffers from the lack of transparency. Costly and time intensive information matching is needed and this is typically done by using paper documents. It's good to keep in mind that from the banks view the trade finance process might seem to be costly and inefficient, but from the corporates view it might look a little different. With the letters of credit the corporates are actually outsourcing additional services, like checking that the goods have arrived, to banks. There have been several attempts to automate the trade finance already, but the document-heavy letters of credit processes have remained. The processes has become more efficient after digitalization of data related to trade, e.g. Bolero, and integration of the ERP systems. (EBA 2016, p.7)

Documentary frauds form an ever-present risk in trade finance, which could be mitigated by the use of transparent distributed ledger. It could also reduce the costs of transaction reconciliation between and within banks. Assurance and authenticity of products in the supply chain could be provided due to the traceability associated with the blockchain.

EBA (2016, p. 9) sees that there are two areas within the trade finance that could especially benefit from the blockchain technology: the transfer of trade information and financing. In these sectors the new technology could rapidly bring benefits to the industry.

By the transparent distributed ledger, there's easy access to data for all parties involved. The data extracted e.g. from invoices or other documents can serve as triggers for executing desired actions automatically using the smart contracts. These triggering events can exist inside or outside the ledger.

The transfer of the ownership of goods is a time-taking process. All participants have their own records and there´s lag in the validation processes between different parties. After the goods have been approved and the ownership has been transferred, there is a lag

in the following actions, e.g. payments. The distributed ledger ensures that all transactions, triggering events and transfer of ownership of the goods are visible for all participants in real-time. This eliminates the need for the participants to individually update the movements to their ledger, making the process faster and more efficient. Also the frauds and errors become less probable as they are likely to be detected due to the several parties involved in the ledger supervision. The use of distributed ledgers in trade transactions is illustrated in Figure 8.

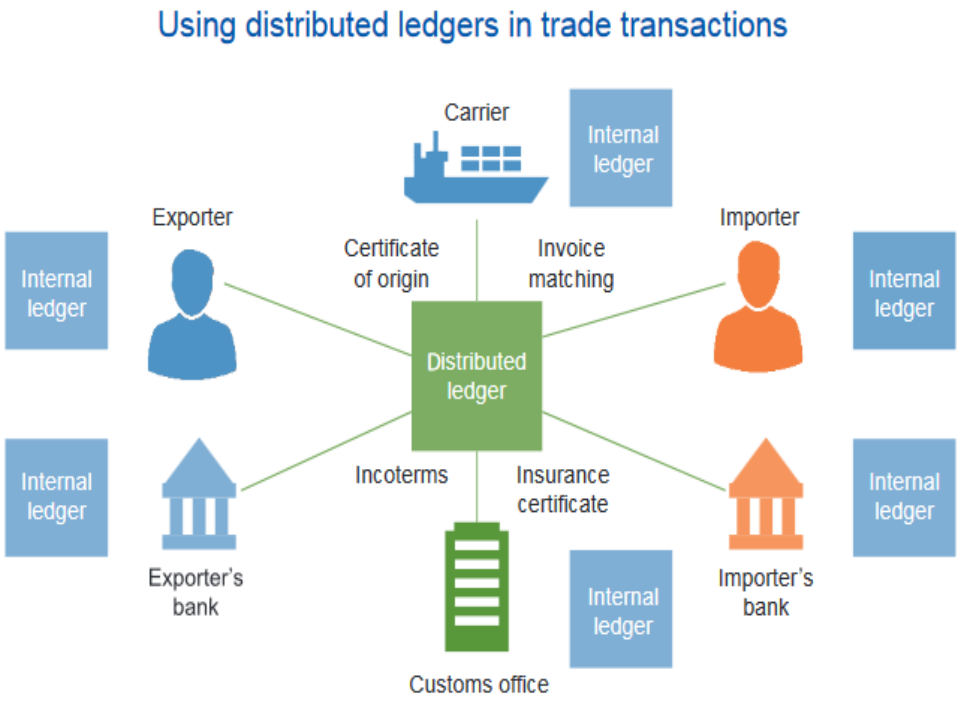


Figure 8. Using distributed ledgers in trade transactions. EBA 2016, p. 10

The smart contracts can also be structured in such a way that they ensure that the funds are not being transferred to banned parties or countries by linking them to embargo and sanctions lists. It's also good to keep in mind that the use of distributed ledger doesn't affect the banks' freedom of choice on how the payment is made. Even though the process is automated and triggered by using smart contracts, the bank isn't forced to send the payment via the distributed ledger. It can still decide to send the payment through legacy system or payment instrument. Whatever the method used for payment, it can still be recorded to the distributed ledger and therefore give other stakeholders the guarantee that the payment has been carried out. (EBA 2016, p. 9)

The speed, efficiency and security also on the financing side would be improved due to the transparent ledger. The amount of manual processing and data matching would significantly decrease and the banks could use these resources on more profitable operations. EBA sees that the financing terms and compliance issues will still be agreed

ou tside the distributed ledger but despite that the common ledger will make financing transactions, e.g. the release of funds happen much quicker.

8.7.2 New kind of financing options

Distributed ledger could also enable more granulated payments. As the transfer of goods is recorded in the common ledger, the payments could easily be fractioned along the supply chain. As all actors would be able to input information on the ledger, the steps in the supply chain process could be used to release smaller portions of funding. This would unlock liquidity and reduce the risk of non-payment. Linked with the development of instant payment systems that is going on at a high pace, the positive effects would become even stronger. Instant payments would further improve the liquidity and the use of working capital.

The blockchain/distributed ledger technology could in the future open opportunities to create an open market. The buyer and seller could share an invoice or at least the main stipulations of it needed for financing to the distributed ledger. The banks and third parties would then provide competitive financing offers. Of course this kind of open market isn't something that the industry is used to, and raises questions about data privacy and compliance related issues, such as the KYC for example. Anyway EBA sees the ability to create open market places as an interesting opportunity for the banking sector to expand their trade finance services. (EBA 2016, p.11)

8.7.3 Challenges

Also Barclays (2016) sees data privacy as one challenge of the distributed ledger. They don't go as far as to open market places, but point out that the maintenance of data privacy among counterparties in normal trade transactions is a problem. They see that this could be solved by utilizing tokenisation as a form of cryptography, whereby parties are only allowed to access permissioned information.

The EBA report (2016, p. 13) points out the typical challenges that are related to all use cases of blockchain technology in financial world. The lack of jurisdiction and the legal status of the transactions carried out in the blockchain are problems that all present in all business fields. However, it's true that there are special challenges in the jurisdictional side as it comes to trade finance, as the parties are operating under very different legal circumstances and the legislation regarding cross-border trade varies a lot. Therefore fulfilling for example the AML and KYC processes is even more difficult than in some other business areas. Sanction and embargo lists have to be taken in account as well. There's also a possibility that the trade information will be transferred on the distributed ledger as some other information between the counterparties will be transferred off-ledger. This would eliminate several problems related to data privacy.

8.7.4 Intelligent shipping containers/Internet of Things

Barclays (2016) points out that the internet of things could be used also in trade finance and combined with the blockchain technology it could be used to move physical assets while they are simultaneously tracked and purchased. There are indeed plans to create a system in which the shipping containers could be managed by the blockchain technology. This kind of technology is being developed at least in Finland. (Newsbtc.com 2016) The shipping containers would automatically record their movements into a blockchain and they would also have their destination encoded so they would automatically take the necessary steps to be carried to the desired destination from their origin.

In the beginning the information needed for the transportation would be encoded to the blockchain application of the container. By using this information it could make independent decisions about its route. At each point of its travel, it could compare the transportation offers provided by different companies, and order the transportation that suits its needs. The container would manage the schedule of the transportation and would be able to plan its own route from the origin to the destination depending on different transportation offers made by companies. The containers could share information and therefore "learn" from each other. The movements of the container could easily be followed by the sender and receiver, and they could also change the route and schedule of the container. The system wouldn't be completely automatic, but the need of human workforce in the cargo handling processes would be significantly smaller and their work tasks would change.

The intelligent shipping containers would make the transportation of goods more efficient, but it would also benefit the trade finance business by ensuring better traceability of the goods transfer. The funding releases performed by different parties could be done in a more real-time manner based on the movements of the cargo. Granular payments might be an interesting possibility here as well. This would lead to increased liquidity and more optimized working capital management.

The blockchain/distributed ledger technology might generalize in trade finance quickly. Trade finance is one of the main topics being researched for example by the R3 group formed by the biggest banks in the world.

8.8 Crowdfunding

8.8.1. Potential of blockchain technology in crowdfunding

The blockchain/distributed ledger technology could also offer a platform to build a liquid aftermarket for startup investments. The blockchain technology is a natural environment for crowdfunding as instant transactions are not necessary and on the other hand, the

amount of transactions is low. Decentralization offers great benefits, and on the other hand, hasn't got significant disadvantages compared to a centralized system when it comes to crowdfunding. (Ivanov 2016, p.5) Ivanov also points out that in case that a legal entity is compliant with the laws and regulations, issuing securities on a blockchain is as legitimate as a stock exchange listing. Despite this, it's especially pointed out in their report that in US the crowdfunding regulations are stricter than in many other countries. There the fundraising is allowed with a simplified SEC procedure. In US the system is structured based on a heavily centralized parties in order to prevent frauds, but Ivanov is optimistic that the situation might change as the authorities see the possibilities that the blockchain/distributed ledger technology enable in security due to its transparency.

Ivanov sees though, that to fulfill the legislation on KYC and AML will require some kind of decentralized party for the crowdfunding system. Also the scalability of the system is seen as a clear restriction, but there's different ways to get pass this problem. The problem is that at some point all nodes won't be able to store the full history of the ledger. This might lead to a more centralized system where some nodes hold the full history where as other, light-weight nodes won't download the blockchain, but will rely on the full nodes for payment verification and network interaction. This makes the light-weight nodes, for example users of a mobile app, vulnerable to frauds performed by the full nodes, but Ivanov sees that this problem can be eliminated by having a list of trusted nodes, or polling several nodes. It also points out that even in this case the system won't be centralized as any node has the opportunity to become a full node in case they have the resources needed for this.

This is one proof that the blockchain/distributed ledger system isn´t ready yet and more research and innovations must be done in order to guarantee it´s reliability also in the future as the amount of transactions increase. The more decentralization needed, the more of the opportunities of the technology will be lost. This is another proof showing that it might not be justifiable to try to implement the blockchain/distributed ledger to all use cases where it might offer some benefits, at least not in the first place. A more intelligent approach would probably be to concentrate on cases where the disadvantages are limited. Several very opposite approaches can easily be found in this scene, as many players seem to be very optimistic of the future opportunities of the technology. It has to be said, though, that it's possible that these positive players are the ones the future proves to being right, as the technology evolves at a high pace now and that technical solutions, that one can't even think of today will be developed in the future. For example, the issuance of central bank based digital currencies, which today doesn´t seem so scifi that it looked just a very little time ago, would solve many of these problems.

There are typically two problems in startup funding. As only a small proportion of startups evolve into successful companies, investing in just one or two companies forms a significant risk to an investor. To reduce its risks, the investor has to either make a lot of

research about the startup and the environment where it´s functioning, or be rather wealthy in order to be able to invest in several companies. Preferably both.

The other problem is related to the long timespan that the investments to startups typically require. Usually the investor has to wait for several years to get any profit from any of its startup investments. There's often no chance to cash out from a company that seems to have a bright future ahead, but isn't going to create profit in the near future. The investor can't simply decide to drag away it's funding in some point, as this would be an end to the whole company. This kind of scenario is ruled out at the time the investment is made. These two features of startup funding often narrow the potential investors to institutions or wealthy business angels.

8.8.2 Funderbeam

Funderbeam is an example of a company that has started to solve these problems by using the blockchain/distributed ledger technology. It offers a marketplace where users are able to buy and sell colored coin stakes in startup syndicates. The platform, like so many other colored coin platforms is based on Bitcoin blockchain. The investors can use Funderbeam to create a syndicate for one or several startups.

In Funderbeam platform there are no limitations on the amount of investors or on the funds they have to place. For example, if some startup is searching for 100 000€, one lead investor can form a syndicate and decide to fund the company by any amount of money. Other investors willing to participate in funding this startup can join with any amount they want. This goes on as long as the desired amount, 100 000€ is full.

After the syndicate has been issued to the companies, the investors have the opportunity buy and sell the colored coins. These coins are a digital presentation of the funding the investor has put to the syndicate. The coins are tradable immediately after their issuance. The distributed ledger offers a marketplace, where parties can place buy and sell bids for the coins. This allows the investors to exit from the investment at a fair price once they have earned a desired profit or want to cut their losses in a startup.

The blockchain technology has also other benefits compared to traditional crowdfunding systems. The technology also provides fast, efficient and transparent asset ownership tracking. The amount of bureaucracy is significantly lower as no business registry, central depository or other such party is involved in the transaction confirmation. The distributed ledger ensures that the information is valid and secured, and therefore there´s no need for this kind of parties to be involved. The efficiency of the platform makes the costs of crowdfunding to be smaller than in the traditional model. The blockchain technology also makes it easier for startups to get funding that is necessary for their growth, as investing in these companies becomes significantly more accessible to investors with smaller funds.

This is likely to result in more startups developing into a success story in the future. On the other hand, it can be said that the new technology brings the investors to same line as the institutional players don't anymore have advantages compared to individuals. (GOS 2016, 82-83, funderbeam.com 2016)

8.9 Land registration

One interesting proof-of-concept case is the blockchain-based real estate registry that is carried out in Sweden. The Swedish National Land Survey (Lantmäteriet) is exploring the case with Chromaway, a Swedish-based blockchain technology company, consulting firm Kairos Future and Telia, a telecommunications operator also being headquartered in Sweden. The idea is to store the information of the ownership of properties in to a blockchain. Due to the transparent distributed ledger, the information of all the transactions of ownership in the property´s history would be available to the parties involved, which would make the sales of properties more secure.

Chromaway provides the smart contract system, whereas Telia has the identification technology needed. The smart contract system is structured in a way that it can be run on a public or private blockchain. In other words, even though at the moment the project is running on a private blockchain maintained by Chromaway, it could also be run using any public blockchain, like the Bitcoin or Ethereum blockchains. This is a creative solution leaving the future open; as mentioned in many reports, the permissioned blockchains are considered safer and more compatible with the legislation and existing systems, whereas Bitcoin, Ethereum or some other permissioless blockchain might evolve in the future so stable and realiable that it will gain also a legal status. The registry and smart contracts involved in it could be integrated to several blockchains at the same time, which of course provides additional security. This approach enables an opportunity to concentrate on developing a functioning system for smart real estate management without stressing on which blockchain will be most useful and dominate in the future.

The benefits of blockchain technology in property management are in the fields of security and facilitating the process. Frauds happen in property sales, says Henrik Hjelte, the CEO of Chromaway. People have managed to get away with selling properties they don´t own. Central databases, on the other hand, are vulnerable to "false update" attacks, whereas the blockchain is secure against this kind of threat as the transactions have to be verified by different parties in order to end up in the blockchain. Blockhain technology adds up a chain of evidence in the ownership history that can´t be altered. There´s several digital signatures needed and multiple copies of the register. The buyer, seller, real estate agency and land registry see the same information. The privacy is secured, as these are the only parties that get access to the data.

The facilitation of a property trading process means that in the future the parties don´t have to be sending contracts, bills of sale, credit and other documents via mail. Often the original documents aren't the ones being posted, but scanned copies instead. In the future all this could be handled by data stored in the blockchain and digital signatures, making the process faster and more secure. (chromaway.com 2016, Mizrahi 2016)

The proof-of-concept project is on land registry, but the same technology could be applied to other valuable items as well, for example cars. Swan (2015, p. 10) takes the idea even further by stating that the blockchain could handle the access rights to homes, hotel rooms or rental cars. Marriage and death certificates or business licences could be maintained in the blockchain as easily as land registry. Goldman Sachs (2016) sees that insuring properties could be added to the blockchain platform as well. The records held in the distributed ledger would identify and provide proof of the owner, which would protect the owner´s rights e.g. in case of a theft. It would prevent sale frauds of valuable items and ensure that the ownership will be correctly transferred to the new owner after the sale. There would no longer be need for a trusted party in order to verify the trade. Of course, in reality, as there´s a fair possibility that for legal and security issues there has to be a provider for a blockchain (in case public blockchains are not seen as a suitable option), there would still be a need for a central party. Also there will always be issues where the ownership of an item will be transferred e.g. through litigation, and therefore a party with the ability to override the ownership rights would be needed. As registers of cars are today maintained by central parties, creating this kind of system would be in line with the existing practices.

8.10 Payment systems

In this chapter we discuss the potential of applying the blockchain technology to payments. This is a typical use case of blockchains, as the cryptocurrencies, like Bitcoin, were created to handle payments. Anyhow, it has become clear that the existing blockchains aren't able to handle the extremely large volume of daily payments made e.g. using credit cards due to scalability issues. Therefore it's important for the banks to consider also other technologies to make the payment systems more efficient. On the other hand it's also possible that the blockchain technology might evolve quickly and the scalability issues might be solved already in the near future. If banks don't focus on creating blockchain-based payment solutions, there´s a fair chance that they will lose significant part of their business to new entrants, as there are numerous startups creating their own wallet and payment applications.

8.10.1 Blockchain technology in the payments sector

Morgan Stanley (2016) sees that domestic payments are already efficient, but international payments could benefit from the blockchain system. The multi-day

settlement periods could be shortened with the new technology, transactions would come faster and risk of frauds would be lowered. Especially as the US is making a transmission to real-time procedure in intra-country payments in the near future, the need for faster international payment transaction system is likely to increase. Morgan Stanley points out Swift and Ripple leading interesting suggestions for the international payments.

The Accenture report (2015) says that many startups are focusing on point solutions, like wallets, exchanges, and security but lack the holistic approach towards industry solutions. Some exceptions, like Ripple, exist though. Especially the regulatory issues are mentioned to be a barrier for the development of these kinds of solutions, as there´s risk for the development the systems to be expensive and time consuming especially for the startups.

Accenture highlights the different views on the development of future systems that can be seen between the smaller players and traditional financial institutions. It says that once the industry gets over the hype and disillusionment on the technology, which is likely to happen rather quickly, the banks should be in the front foot, ready to experiment, learn, plan and architect the new solutions as it sees that the new technology truly has a great potential.

Banks shouldn't dismiss the potential of blockchain/distributed ledger technology, nor decide to monitor the development of the systems from the side, as this has high risks of dropping off from the technical development in the quickly changing markets. New entrants have dragged some parts of business that has traditionally been basis of banking industry, such as lending. Also new kind of payment platforms are continuously being introduced to customers. The banks simply can't just wait and see what the fintech companies will create when it comes to blockchain. They have to be in the frontline or there´s a risk of them slowly losing their whole business. (Accenture 2015). It has to be said that the major banks already have made the same conclusions, the R3 group being probably the most visible sign of it.

Many times the blockchain/distributed ledger technology is said to revolutionize the payment systems, as it offers real-time and efficient transactions. Many existing systems are slow and paper-driven, so in this sense it´s not surprising that these kind of arguments exist. However, it´s important to bear in mind that in some markets high-volume, low-cost and real-time payment solutions do exist, and that these are constructed without blockchain. Accenture (2015) says that the payments sector is a more difficult environment for blockchain than situations where the ownership and transactions of assets are handled through complex settlement and clearing procedures.

In other words, there´s several other technologies than can be implemented to improve the efficiency of payments. The scalability of blockchain/distributed ledger technology is

often raised as one disadvantage in high-volume markets, of which the payment sector is a perfect example. Anyhow, it´s possible that these issues will be eliminated as the blockchain technology develops.

This raises a question of what do the payments sector need the blockchain for. Accenture (2015) says that the new technology can provide solutions for situations where the current technology isn´t feasible. The transparent distributed ledger is, for example, usable in cross-border payments, where oversight can't be done in a traditional way by a central party. The implementation of blockchain will be useful in any situation where unnecessary costs, restrictions, barriers or intermediaries exist.

Accenture says that if the blockchain technology becomes widely adopted, it might enable totally new kind of payment systems as it´s designed to eliminate the need for trust between parties, as execution of transactions and contracts are done automatically by a predefined code that can´t be altered by any party. This means that in the future, banks could do business with other financial institutions around the globe without a need of an existing, trusted relationship.

The transition from the existing payment systems to blockchain-based systems would require massive change in the banks' infrastructure. A blockchain purely for payments would require some kind of wallets for the customers. Probably this would mean converting the traditional accounts to wallets that are integrated in the payments blockhain. So far there has been a little discussion on this topic.

8.10.2 Why should banks apply blockchain to payments? – Two Reasons

It seems that banks are having two different reasons on why to develop blockchain-based payment solutions; the potential cost savings and the threat of new entrants coming into the payment markets. However, these factors have to be approached from very different basis. Accenture (2015) points out that the costs that banks face from handling payments come from five areas: manual processing, third-party fees in the supplement chain, fraud losses and anti-fraud, KYC and AML costs, complexities of cross-border settlement between banks and legacy systems and processes, often with overlapping and duplicate functions, data and processes.

To achieve cost savings, the banks should of course focus on creating blockchain solutions for these kind of processes. Controversially, what many of the new agile entrants are doing is that they create platforms that individuals can easily use for the payments in their everyday life. Think of the way Uber functions. It doesn´t really offer cheaper taxi services than the traditional taxi companies (even though more sophisticated ride-sharing solutions are being developed for it, which might lead to reduced cost for customers as

well). What it does is that it simplifies the whole procedure. No matter in which country you are, simply open the app and order a cab. No need to search for the right telephone number, to stress whether your credit card will be accepted or to change currency to get a ride. The payment is automatically charged from your credit card. The customers are willing to use easy solutions that facilitate their life, the banks have to keep this in mind when designing new payment applications.

Think what would happen if Uber decided to issue its own virtual currency. Let's name this hypothetical currency as Ucoin. The wallet would be integrated in the app and the payment would automatically be charged in Ucoins. It could have huge cost savings as there would be no credit card companies acting as intermediaries and taking their share of the profits. Uber might be able to encourage the customers to use Ucoins instead of their credit card by offering cheaper rides in the beginning. At some point, as the Ucoins get widely adopted, the credit card option might get completely useless. A major loss for the credit card companies.

The development wouldn't have to end here. This kind of killer app that has gained a wide popularity could start cooperation with other businesses, like restaurants, shops, or virtually any service provided to customers. Going to your local McDonalds, you could place your order and after that read a QR-code with your Uber app and the payment would be automatically charged from your Ucoin account. Or maybe the McDonalds could create its own app, where the order is placed in advance and would be ready at the counter waiting for you as you arrive. The payment would be done automatically using Ucoins, no need to even have a wallet with you anymore. Maybe in the future the counters in supermarkets could be that evolved that they automatically read the contents of your shopping trolley without the need of actually placing the products to the counter. Simply walk through the gates that read your purchases and charge the right amount of Ucoins.

Of course, there´s no need for Uber or any other new entrant enable this kind of future. The banks could do it themselves. There might not be need for blockchain either, the customer doesn't care what's the technology behind the system as long as it's secure and easy to use. At the moment banks are working on their mobile payment apps that don't utilize the blockchain technology. It might be that they evolve to be extremely useful and answer the needs of customers. Anyhow, the blockchain technology enables easy and lightweight mobile wallets, as we have seen in the case of Bitcoin. Even though the banks wouldn´t find that significant cost saving potential in utilizing the blockchain in everyday payment systems, they should be there developing their own, superior solutions to prevent entrants taking over their business.

The creation of payment applications done by several startups is often based on colored coins and the Bitcoin blockchain. This kind of approach has its vulnerabilities and therefore probably isn't appealing to traditional banks that can't take a risk of ruining the

reputation they have gained over decades by creating a platform that might end up being a catastrophe. The startups don't have this kind of problems, they can experiment new technology freely and create valiant solutions and monitor whether these become popular. Major issue in these systems has been the lack of jurisdiction on blockchain and the need to fulfill AML issues.

The use of Bitcoin blockchain means that any company could issue their own digital coins and have a mobile app working as a wallet. There´s no need for capital-intensive investments in hardware or anything like that, the Bitcoin miners are doing the maintenance for you. There simply has to be an exchange where the customer can exchange fiat currency into colored coins and the other way around.

Richard Olsen, the founder of Lykke Markets, illustrated the future world where say a pizza company could issue pizzacoins which could be used in the restaurants of the chain. Similarly a taxi company could issue taxicoins that would be used for payments in consortium of taxi companies. Lykke would offer the platform, including the necessary mobile apps and exchange needed to convert fiat and digital currencies. The platform would be easy and cost-effective for the company. Customers would benefit from the easy payment system: no need to carry cash as the payment would be automatically charges from your phone.

Anyhow, with the existing colored coin technology this seems to benefit more the company than the customer. The company could get significant cost savings and benefit from the real-time payments but it just doesn't seem too handy for the customer to have to deal with a separate mobile app or at least a different digital currency every time they go to some store or restaurant. Why not just use cash, or even better, the mobile payment apps that the banks will be likely to have in wide use shortly?

Some kind of universal solution should be constructed, so that the customers would take the virtual currency into use. The technology is evolving at a high pace, so this is in no way impossible. Bitcoin itself has been a good example of a useful payment method, but as it is designed to be anonymous it has the AML and other issues. Anyhow, it's not impossible that some party finds a functioning solution that solves the problems. Probably the issuance of a central-bank based virtual currency, that doesn't seem so impossible that it used to be regarded just a little time ago, would eliminate many of these problems and enable huge opportunities for the startups creating their own mobile payment platforms.

Uber was taken as an example of a killer application that has quickly gained wide adoption and therefore could have the possibility to get its own currency to be widely adopted. Of course this isn´t likely to happen but it´s a good illustration of the big changes that could happen in the future in financial markets. Google or some other significant player in the virtual industry might have similar kind of opportunities to ensure a massive

adoption of a virtual currency that might radically change the payments segment if the legislators allow this kind of development.

Naturally, at the moment this doesn´t seem likely to happen, as the financial system is such a significant part of all societies. Therefore it would be surprising if the governments would give away their possibilities of controlling the system. Anyhow the digitalization has already driven many radical transformations in different fields of society and this has happened in a pace that would have been difficult to imagine just a few decades years ago. The digitalization continues to be a megatrend in the future and certainly there will be lots of transformations that don't seem so obvious at the moment.

Also the Accenture report (2015) sees that in the future at least one global virtual currency, like Bitcoin, might evolve, being independent of government control. Despite this, the users would still be subjected to be under the supervision of their governments. Over time the cryptocurrencies might become important tools in financial world, especially in international trade and payments, but Accenture sees that they would be used alongside the fiat currencies rather than replacing them. In this kind of system there would be a need for marketplace for the digital currency, and this node of the network would allow the governments to supervise the usage of the currency.

Accenture (2015) says that banks have two possibilities to utilize the blockchain/distributed ledger technology in the payments sector in the future. The blockchain can be used to facilitate the payments in fiat currencies. In this scenario the technology would supplement the existing systems and could be used in payments, cash management and trade services. The services to customers would be similar to the existing ones, even though there would be options to facilitate the payments directly from the bank accounts rather than using card payments. There would also be opportunities to provide new kind of liquidity and interbank settlement services, like the market making services in the Ripple network.

The more radical approach would be to create a solution that uses virtual currencies to handle all aspects in the payments and eliminate the need for fiat currency. In this scenario solving the AML and KYC issues is a major challenge to be handled. If a solution is found, the regulation will likely adopt to the new technology. A system using a global, stable and universally accepted currency is highly attractive to several parties in retail commerce, trading and cash management sectors and therefore the evolution of this kind of system is possible.

If this scenario will happen, the banks have different kind of services to provide for their customers. First of all, the banks should offer digital wallets that their customers could use for making payments in virtual currencies. They would also be offering cryptocurrency deposit services. This is necessary as the digital wallets aren´t safe

solutions to store large amounts of money. For example, the Bitcoin users typically hold only a limited amount of BTC in their online wallets that they use for transactions. The BTC wallet is a computer or mobile application that typically is continuously connected to internet and therefore it only has a limited security as the wallet can be hacked or in case the mobile phone or computer hard disk gets damaged or lost, the user will lose the BTC that are on their wallet.

Instead, the users store their BTC on wallets that are on external memory or in a paper wallet (which has a piece of code that can later be written to the wallet application to get the BTC for use) and have also several copies of these wallets in different external memories in order to guarantee the files containing their BTC won´t get lost. The user can then transfer the amount they desire from these external memories to their online wallets to handle their daily transactions. In other words, the online application acts like a traditional wallet where you store only the amount of cash needed for the everyday use and the external memories can be considered as traditional bank accounts where the greater amounts are stored. Banks would offer this kind of safe deposits from where the virtual currency would easy to transfer to wallets.

Banks would also offer digital exchange services in which the FX between virtual currency and fiat would be possible and ATM's, where the users could buy and sell their digital currencies using physical cash. These kinds of services for Bitcoin are already being offered by several startups.

The banks would also offer corporate cash management services which would include sweeping and pooling into cryptocurrencies and offer near real-time cross-border transfers. Also better international payment services would be offered to individuals. Banks could offer analytics services that would enable better cash flow and balance information and forecasts to corporations. The API services that enable third parties to have access to customer wallets embedding them into their own applications and services would also be an important part of the services that financial institutions could offer their clients in the cryptocurrency world. (Accenture 2015)

8.11 Settlement and clearing – Case Lykke & IATA

Settlement and clearing are one of the most potential use cases of blockchain technology. In this chapter we examine a broader example of how the blockchain could be used in order to make the functioning of clearing houses more efficient. The details for this example are provided by Lykke, which has made a pilot study on improving the clearing and settlement services provided by the IATA Clearing House. This is an illustrative example in two different ways; it offers rather detailed information on how this particular procedure can be made more efficient using the colored coins –based platform provided by Lykke, but on a higher level it can be understood as an example of how the

blockchain/distributed ledger technology can be used to improve settlement and clearing of any asset class in different markets.

8.11.1 About IATA

IATA (The International Air Transport Association) is a trade association for airlines. In 2016, it has some 260 airlines as it members, which together represent about 83% of total air traffic. IATA was founded in Havana, Cuba in April 1945. At this time IATA had 57 members from 31 countries, mainly from Europe. Since the foundation of IATA, the scheduled air transport industry has become over 100 times larger. Today IATA's members come from 117 nations from all over the globe. IATA membership is open to airlines operating air services that maintain an IATA Operational Safety Audit registration.

IATA defines its mission to "be the force for value creation and innovation driving a safe, secure and profitable air transport industry that sustainably connects and enriches our world." Its mission statements are to represent, lead and serve the airline industry. IATA's target in representing the industry is to improve understanding of the air transport industry among the decision makers to strive for sensible regulation. Throughout its history of 70 years IATA has been developing the commercial standards of the airline business. Therefore it's safe to say that IATA is a significant counterparty in leading the industry. It aims to simplify processes, to increase passenger convenience and to reduce costs by improving efficiency. IATA works to make the air transport safe, secure, efficient and economical. This includes defining clear rules for the air transportation. IATA also provides support for all the industry stakeholders with a wide range of products and expert services. (iata.org 2016a)

8.11.2 IATA Clearing House

The IATA Clearing House (ICH) is a platform serving the air transport industry. It provides settlement services for its members. ICH was founded in 1947, two years after the foundation of IATA. It is the longest-running and most important part of IATA. It has about 275 Airline members, both IATA, and non-IATA members. In addition it has around 75 non-airline members. The ICH membership is free for airlines that are IATA members. Non-IATA airlines, and non-airline members, such as handling agents, engineering companies, airplane manufacturers and other strategic partners pay a membership fee. ICH also receives income from e.g. penalty fees for late payments.

The ICH members are in close collaboration with each other, and typically they have two-way billings. By applying the principles of set-off/netting it reduces significantly the amount of cash required to settle them. The offset ratio of ICH has been approximately 70% in the past. The offset ratio is the amount of cash transfers reduced by the platform.

In addition to more efficient use of working capital it also significantly reduces the settlement risks of its participants. Offset is especially important for the airline members, whereas the suppliers are mostly only receiving payments.

Other important benefits of the system are reduced transaction fees and increased speed of the transactions. ICH manages over $43 billion per year in billings, and $300 million is paid out weekly. Transactions include Passenger, Cargo, UATP and Miscellaneous categories. The clearing period is typically 2 weeks.

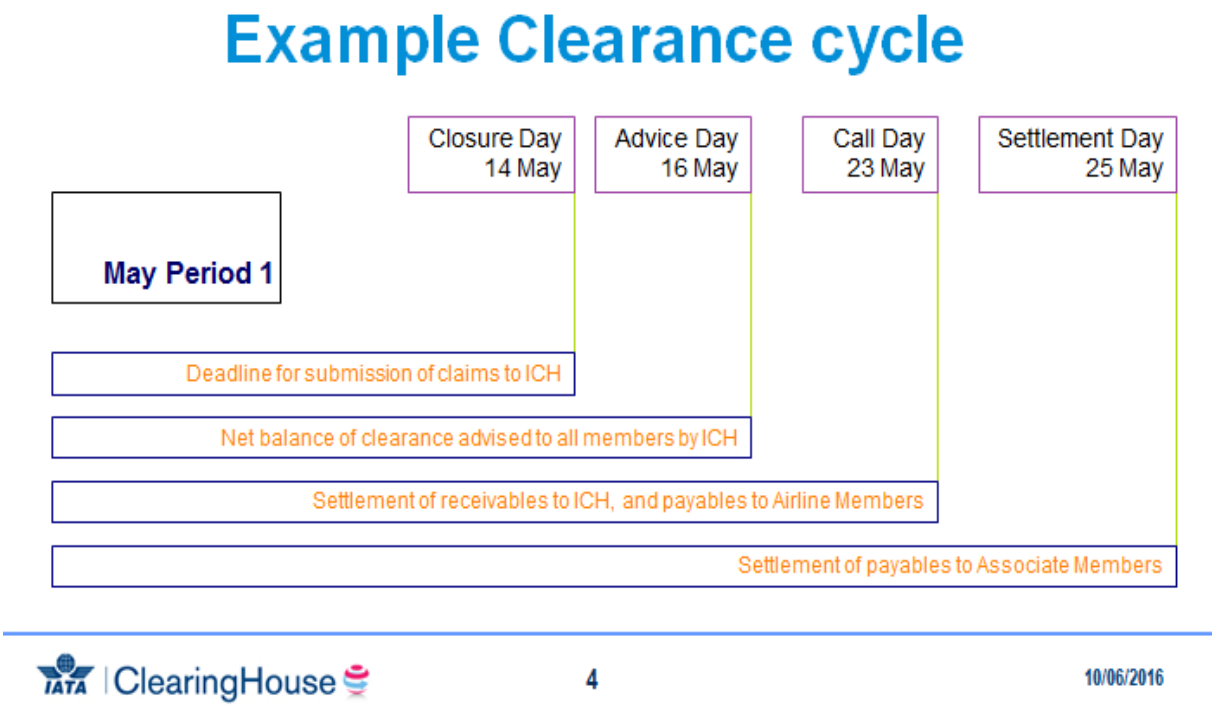


Figure 9. ICH Clearance cycle. Coote 2016a.

The clearing cycle is described in Figure 9. Each member enters their claims at ICH for each of its customers before the closure day. ICH does the offset of the claims against the members and the net balance of the member is viewable immediately online. On advice day ICH sends a confirmation message of the final balances to the members. Week after this, on the call day, the net debtors must pay their balance to ICH and two days later the net creditors will receive their payments.

ICH manages the credit control and risk by having severe sanctions for late remittance. For example, if a member is repeatedly late with its remittance it will be imposed early payments in the following clearance periods, it might have to provide a security deposit to the ICH, or even face a suspension if it doesn't settle its debts full after three working days. In case of bankruptcy of some debtor the ICH files claims on behalf of all members.

The ICH has proved to be reliable and its settlement ratio over 12 years is over 99.99%. Despite its long history and success in the past, ICH could face competition from other air transport clearing houses, for example such as the ACH, ACCA and airline alliances. In recent years ICH has lost some members, in 2014 it had over 400 participants compared to the 350 in 2016. (iata.org 2016b, IATA 2016, Coote, 2016a, Coote, 2016b)

8.11.3 Improving the ICH with blockchain technology

With the platform of Lykke the ICH members can gain more flexibility to payment calendar, decrease the costs of moving money and better manage the liquidity and FX risks. For IATA Lykke offers two options to utilize the blockchain/distributed ledger technology: colored coins issuance and IATA coin issuance. Even though these are named differently, they are both based on the colored coin technology and the Bitcoin blockchain.

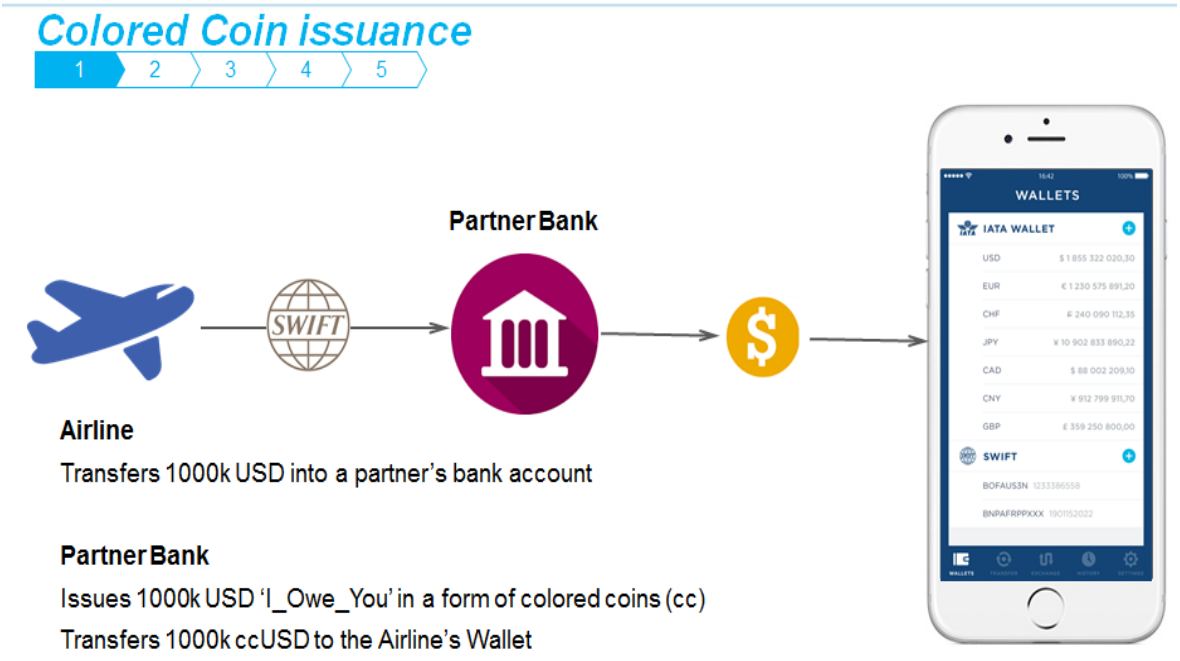


Figure 10. Colored coin issuance. IATA 2016.

The colored coin issuance is described in Figure 10. The partner bank will exchange the fiat currency into virtual currency and transfer it to the airline's wallet. The ICH members can settle the payments using the virtual currency. The fulfillment of the virtual currency works the other way around. The airline will request the coins to the partner bank, which will then exchange it to fiat currency and transfer it to the airline's bank account.

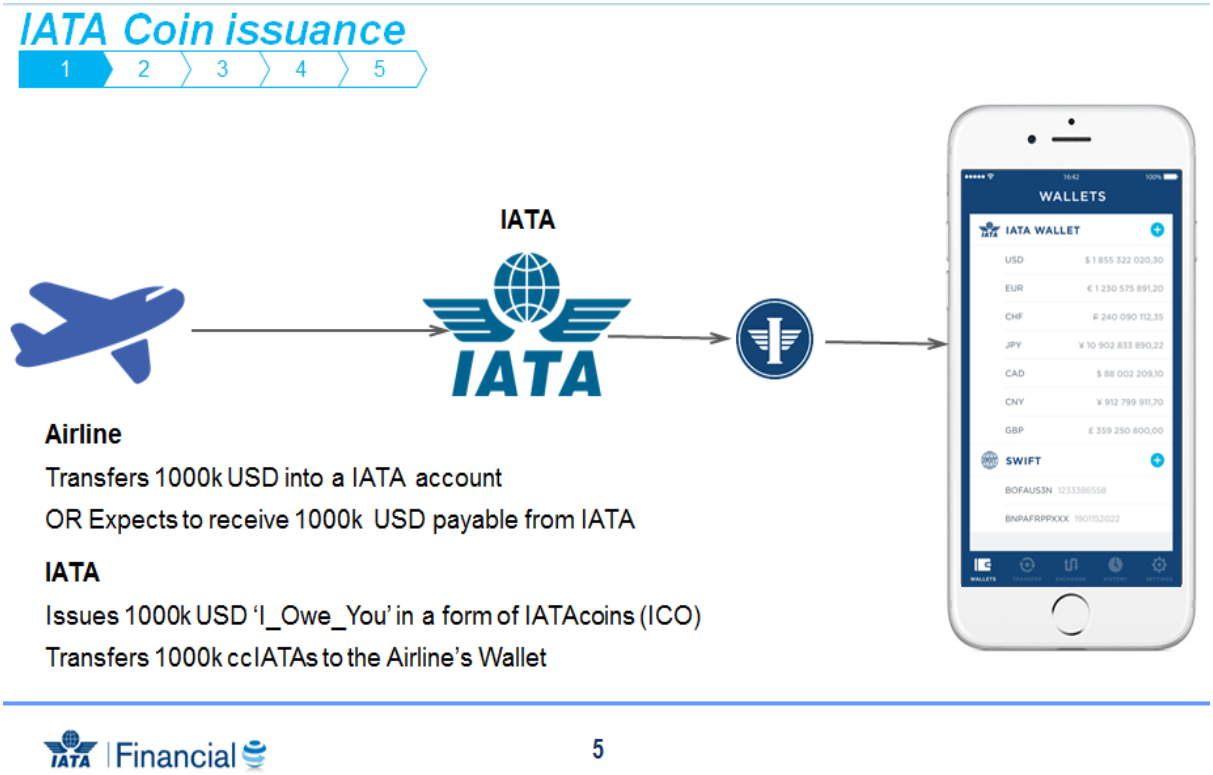


Figure 11. IATA Coin issuance. IATA 2016.

Another option to execute the platform is to create IATA Coins (ICO) as described in Figure 11. In this scenario there's no partner bank, as IATA is being the central party. The main idea and benefits of the platform are similar as in the colored coin scenario. In case the airline wants to exchange its virtual currency back to fiat, it will send a request to IATA, which then will transfer the funds to the airline's bank account.

There are several benefits in the use of the new platform. The payments will become significantly faster, with virtually instant confirmation and settlement into distributed ledger in less than 20 minutes. Liquidity management will be improved with the "ad-hoc" liquidity provision inside current clearance cycle. The balances and transfers will be easy to monitor due to the transparent distributed ledger to all members and a simple mobile application for the CFO-level.

The amount of swift transfers will decrease, which leads to significant cost reductions. The complexity of swift transfers compared to virtual currency transfers is described in Figure 12.

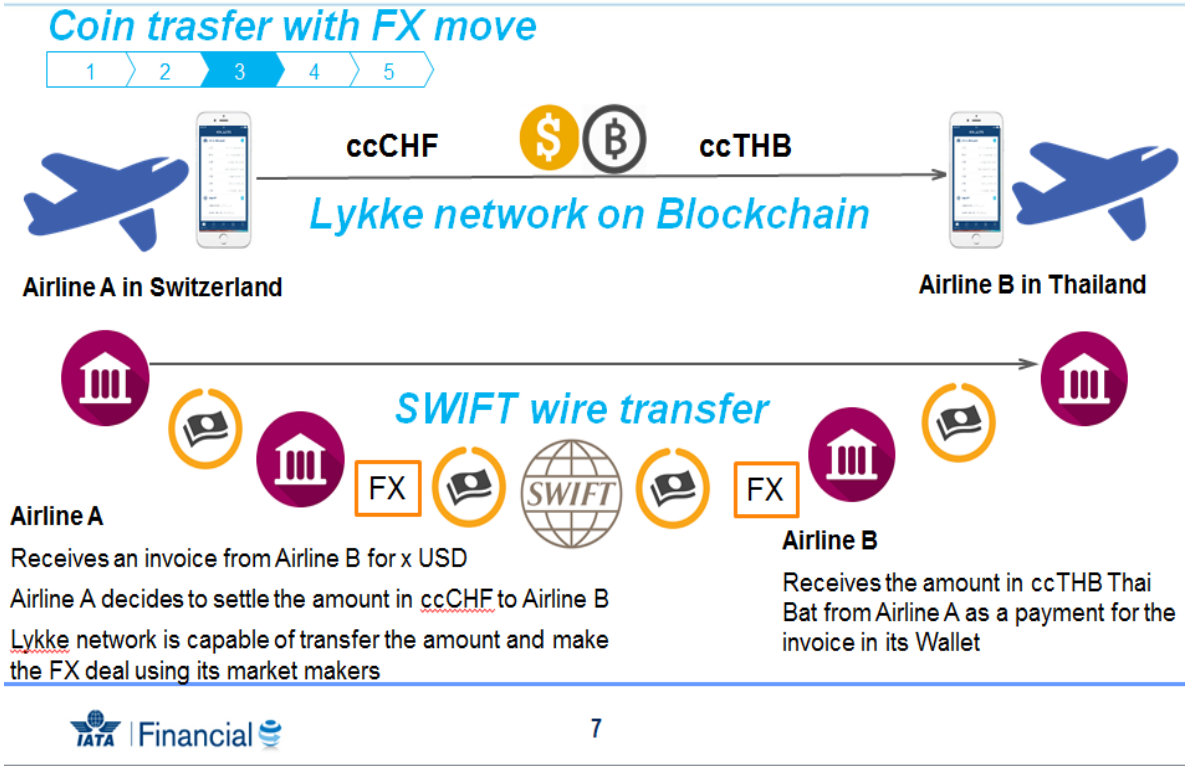


Figure 12. Virtual currency vs. SWIFT transfer. IATA 2016.

In case there's no need for the FX, the swift transfer will be slightly more simple, but still there will be several steps in the process. Digital currency has also another benefit related to FX. It makes the transactions of blocked funds easier. Some countries have imposed restrictions on the transactions of foreign currencies. The airlines can handle the payments by using IATA Coins and then trade them into their desired currency. The new platform makes it possible to handle different currencies, as the Lykke network is capable of doing FX deals quickly and efficiently. This offers ICH a chance to improve its service, as at the moment it only handles GBP, EUR and USD, however JPY and AUD will be added in the future.

Lykke made simulations to compare the performance of the current ICH procedure and the new platform. In the "ad-hoc" smart clearing algorithm first the planned payments between IATA and the airline for the next 14 days were extracted and the cumulative amount of payments was calculated. Next step of the procedure was to select a day for which the cumulative value was minimal and to make an "ad-hoc" payment. From this date the procedure was repeated and a new 14-day period started.

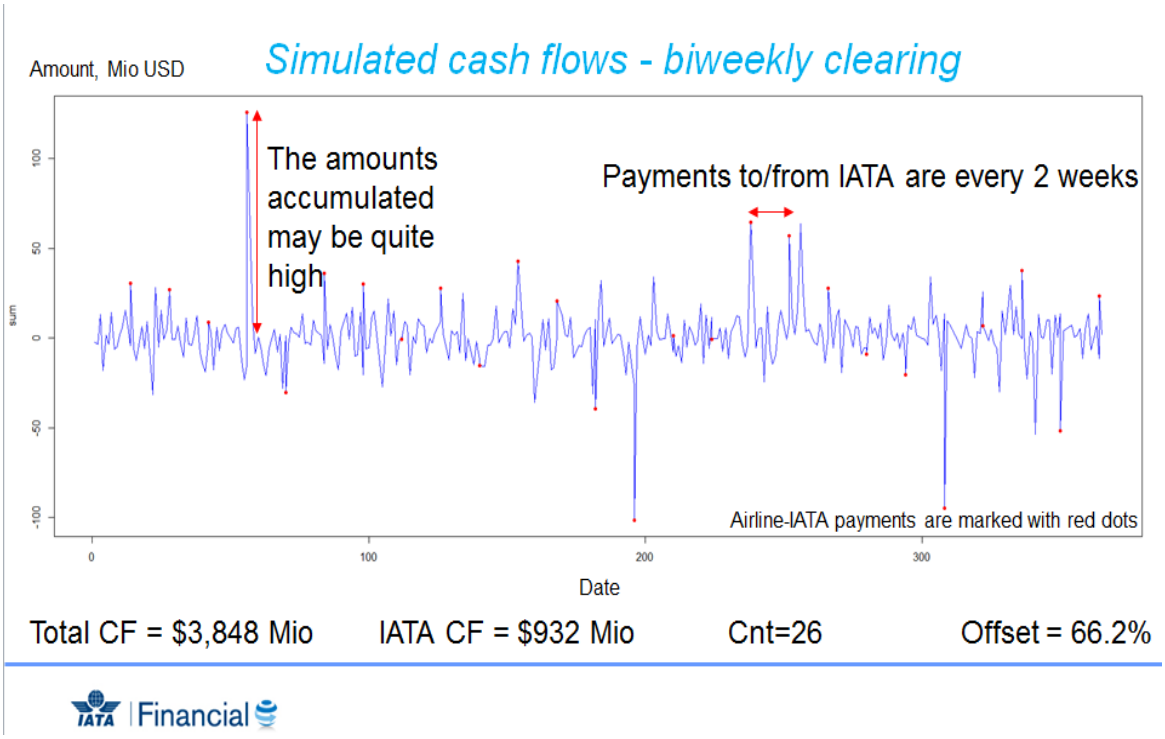


Figure 13. Simulated cash flows in existing platform. IATA 2016.

The cash flows of the existing ICH procedure and the new platform are illustrated in Figures 13 and 14. The benefits of the new Lykke platform are significant. The offset was increased by approximately 10%, payments were done more frequently and the total cash transferred was 20-30% less. This leads to reduced transaction fees and decreased need of working capital.

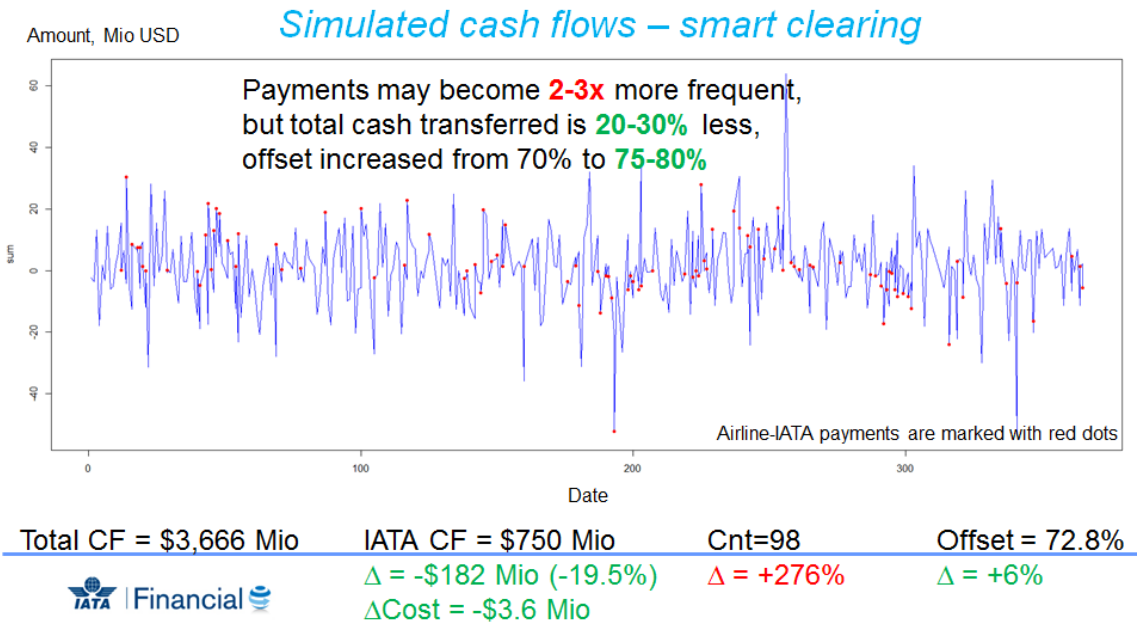


Figure 14. Simulated cash flows in the new platform. IATA 2016.

The simulations show that Lykke has succeeded in structuring the settlement platform. Mori (2016) points out the issues that blockchain technology might have when it comes to settlement. Blockchain technology enables a situation where a central counterparty isn't needed. As the blockchain works with virtually real-time settlement of transactions, the efficiency might be reduced, as netting is impossible. Regarding capital charges under the Basel Accord, the capital charge is 2 per cent if a central counterparty is used. Anyhow, as there is no possibility for netting in a system without a central counterparty, more working capital would be required.

Lykke hasn't tried to develop this kind of system with no central counterparty, which seems to be a wise choice. The structure where ICH keeps acting as a central counterparty is probably the most efficient and especially benefits from its congruent design with the existing system. This makes it possible to be implemented in practice rather smoothly and the cost of the new system is likely to stay moderate as no major hardware investments are needed. The new system increased the offset significantly and reduced the need of SWIFT transfers. From this point of view the deployment of Lykke's platform would seem to be a reasonable step to take.

Anyhow, there are risks in adopting the new system. As the Lykke platform is based on the Bitcoin blockchain, ICH must be confident with the stability and security of Bitcoin. Still, the cryptocurrency hasn't been in wide use for more than just a couple of years so far, and it's impossible to say what the situation will be like for example after a decade. It's clear that ICH can't take the risk of abandoning its current, reliable platform in irreversible and replacing this with a system that relies on Bitcoin. If the new system doesn't require abandoning the current platform, the situation is different. In case that ICH can switch back to the current system without significant costs or disruptions, the threshold for deploying the new system is significantly lower. Other influential aspect when it comes to long-term reliability of the system is whether it can easily be switched from Bitcoin to some other blockchain. If this kind of alterations are not possible in the future, it doesn't seem a responsible choice for ICH to implement the new system.

9. Signs of overheating in the blockchain scene?

When following the discussion that is going on in the blockchain/distributed ledger scene, it becomes quickly clear that there are many parties that are extremely positive on the new technology. The potential of the new technology seems to be widely acknowledged, as it isn't easy to find opinions stating that the blockchain couldn't be a revolutionizer in many fields. Still, there isn't yet much proof of the functionality of the technology in different solutions, and many parties see that blockchain should, at least in the early stages, be implemented in markets where it´s easiest and offers most improvements in efficiency.

In this chapter we discuss the possible overhype that exists in the blockchain scene and illustrate this with an example that deals with implementing the blockchain technology into energy markets.

9.1 Background

Swan (2015) says that the blockchain does not only have the potential to reinvent every category of monetary markets, payments, financial services and economics, but could also "offer similar reconfiguration possibilities to all industries and even more broadly, to nearly all areas of human endeavor". As the limitations of the technology, especially the scalability issues and the resources needed to encrypt transactions are known, it has to be said that these kind of visions should not be accepted without criticism.

For example, Morgan Stanley (2016) has found a study which implies that to encrypt all the permutations of the citizens in Germany and the spectrum of bank products used in the country would use more energy than is produced in the country annually. Morgan Stanley says that they are seeing various iterations of the blockchain concept emerging that better limit network effect and its impact on hardware requirements. Many new blockchain proposals have tried to find ways to reduce the network effects.

Some common ideas on how to achieve these reductions are limiting the amount of nodes, which could be done in a permissioned system, centralizing the distributed ledger completely or partially, paring the blockchain ledger under certain circumstances, making block sizes and their analysis more variable and incorporating data analytics and probabilities into the verification process. It´s clear that all of these options have their downsides, and especially centralizing the ledger would ruin a major part of the benefits of the technology, even though it might work in some circumstances.

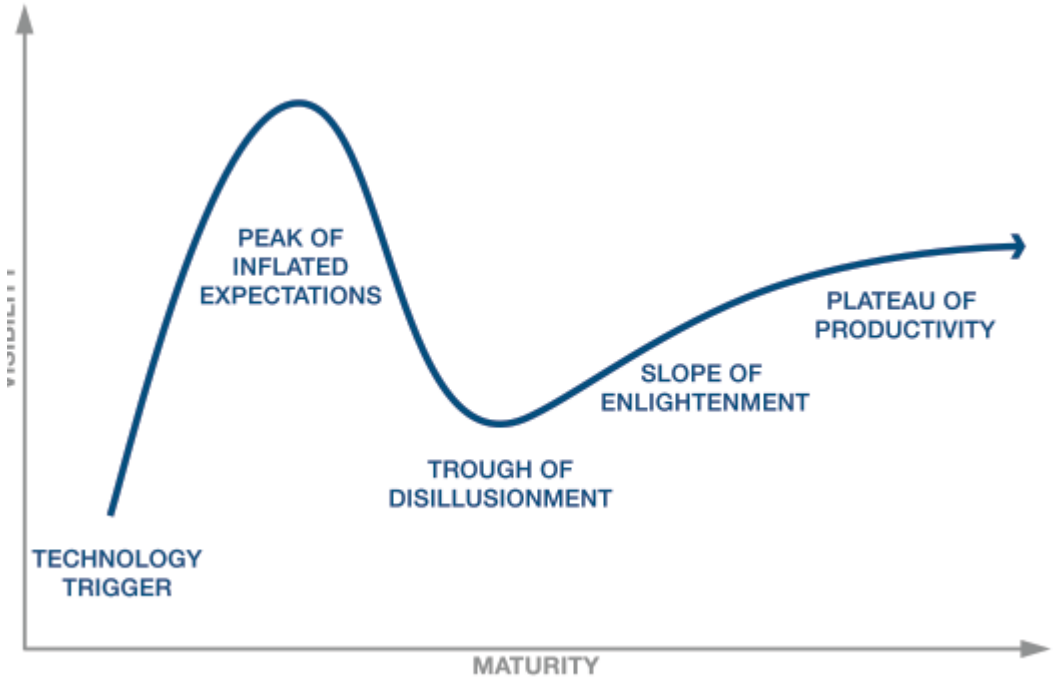


Figure 15. The technology hype cycle. Canning & Swords 2016.

Canning & Swords (2016) see that the blockchain technology at the moment is at the early phase of Gartner's "technology hype cycle" seen in Figure 15.

Even though numerous organizations support the blockchain technology, some also expressed their reservations. Euroclear is one example. It recently released a white paper supporting the potential of blockchains but it also so expressing reservations concluding that there are number of issues that need to be solved in order for the blockchains to gain a widespread acceptance. They say that existing techniques such as Central Securities Depository (CSD) may also perform the same functions as the blockchains. Other institutions also expressed their reservation. (Blower et al 2016)

Blower et al (2016) also say that the existing blockchain technologies have features that are not suitable for financial markets. They see that the technology can be developed further in order to better match the qualities needed in financial world, but this is not that easy a task. They see that the financial markets will in the future have different kinds of blockchains for different purposes, they see that it's possible to create suitable blockchains for e.g. trading and accounting, but these blockchains arent't suitable for other operations. Once the functionality of a blockchain is isolated, the blockchain can be better optimized for its only function. This view is very different to what the fintech companies seem to have, as they create all kind of applications based on the Bitcoin blockchain. As we remember from the Lykke example, they have the vision that all transactions, trades etc. would be carried out using one blockchain that is universal and accessible to everyone like the internet.

Intuitively, if a separate blockchain system is needed for different functions, the difficulty of creating universal solutions that all the different parties (various banks, institutions, regulators, clients etc.) would utilize becomes even more difficult and requires even more cooperation between the parties. This is a hurdle, as we remember that in order to gain the full benefits offered by the blockchain technology, a somewhat "universal" solution is needed, as in a situation where each party has its individual systems, many of the benefits of blockchain technology are lost.

Accenture (2015) reminds, that so far the Bitcoin is the only solution utilizing the blockchain/distributed ledger technology that has gained a wider adoption. No other successful business outcomes have been developed so far and the experience in using the technology is limited. It says that much more research is needed to provide evidence that determines the true potential of the technology.

Also Panayi & Peters (2015) say that there are several different avenues in the financial world for the deployment of blockchains. Several potential use cases have been identified, but Panayi & Peters say that they are "however unaware of any papers that go beyond this high level discussion and detail exactly how and what form blockchain technology may provide benefit in these aspects in banking settings." It's not that difficult to make a similar notice when browsing different kind of visions that various parties in the blockchain scene have. Many participants seem to be blinded by the great potential of the new technology and forget that there aren't yet functioning solutions and for several potential use cases, creating this kind of solutions is a challenging, time and capital-consuming process.

Morini (2016, p.1) points out that the cryptocurrency technology as it is at the moment isn't useful to the financial world. He says there's too much hype about the technology at the moment and misbeliefs that the new distributed ledger/blockchain technology could be implemented to existing business operations as they are and make them more efficient. His view is that while doing so, the benefits of the technology will be lost and only the inefficiencies will be left. The efficient use of the new technology requires that hand-in-hand with the implementation of the new technology comes reformation of the business models themselves. Distributed ledger and blockchain offer great opportunities, but they should be considered as inspiration to new kind of accounting and legal systems.

There are anyhow different kinds of views as well. Morgan Stanley (2016), on their behalf, see that the blockchains do not have to entail whole new IT systems, but rather plug in with the existing technology. Financial insitutions can't, according to Morgan Stanley, reinvent their financial technology or rely too much on it until the new technology is proven.

9.2 Descriptive example – Blockchain revolutionizes the energy markets?

9.2.1 Distributed production

The UK Government Office for Science report (GOS 2016, p. 76) says that in the future the blockchain technology might be useful in the energy markets. Also Goldman Sachs (2016) has expressed similar kinds of visions. The increasing distributed energy production, so called micro-production is constantly increasing due to evolving renewable energy solutions that are becoming competitive option for households. The smart-grids are already adopted in many markets and the path for them to become a standard is clear. Anyhow, GOS points out that the energy market is being served by bilateral agreements between retail energy suppliers and the micro-producers. Therefore the micro-producers, who also act as customers don't have an open access to the markets. The distributed ledger technology combined with smart metering systems and next generation batteries could enable an open access to the markets for the micro-producers.

The smart meters would automatically record the consumption and production of each household to the system. The self-generated energy would be either consumed in the house, stored to batteries or given back to grid. The distributed ledger system would automatically do the netting so the own production and usage of imported energy would compensate each other. Anyhow GOS says that the concept could evolve to an even higher level: if the micro-producers don´t use all the energy they have produced, they wouldn´t have to sell it but they could use it for example to charge the battery of an electric car when they are travelling somewhere around Europe. The distributed ledger would create a market place for the electricity, as the micro-producer could sell it to a counterparty that pays the highest price, just like in stock markets.

These kinds of visions about the potential use cases are great examples of the hype that has overheated the discussion about the revolutionary new blockckhain/distributed technology. To begin with, it seems pretty clear that the distributed energy production will increase in the future and the smart grids and intelligent meters could record the production and usage of each node in the electricity distribution chain. Anyhow, without huge new innovations, the growth potential of the distributed energy production is limited in the near future.

To explain the hurdles, let´s consider a situation, where basically all households in a suburb are producing energy by solar panels. At state A, sun is shining brightly and the solar panels are producing energy at a high rate. In state A there's no energy distributed to the suburb from traditional, big energy production plant, let it be in this case for example a nuclear plant. Suddenly a cloud appears, and shadows a major part of the suburb, this kind of changes happen constantly. Let´s call this state B. What happens now

is that a major part of the energy production in the suburb disappears in a blink of an eye. The energy consumption, though, remains stable. The electricity distribution network isn't capable of handling this kind of quick changes. It can't instantly deliver the necessary power from a nuclear plant to fulfill the need. This causes the voltage to in the distribution network in the area of the suburb to decrease. The network can only handle a rather moderate variation of voltage, and a radical decrease is likely to make the whole network fall.

If the change happens the other way, from state B to state A, this situation isn't any better. There will be a sharp increase in production which, in case the consumption doesn't quickly rise, leads to an increase in voltage in the network, which also causes difficulties to the functioning of the distribution network. There are also other severe issues, like the protection of the grid in case of errors, such as lightning and breakdowns in the network. To build protection to a distribution network with several micro-producers is very expensive. As long as the solar energy production is rather small, i.e. the amount of micro-producers is little, the network can handle these changes. Greater adoption of the distributed energy production, though is impossible, at least in economical frames, to carry out with the existing technology.

The GOS solves this problem by relying on new technology, like next generation of batteries. An economic, efficient, and nature-friendly way of storing electrical energy would solve several problems of distributed energy production, as the overproduction could be used to charge batteries, and in case of underproduction the energy could be transferred instantly to the grid from the batteries. The problem is that to assume that these kinds of innovations will be made in the near future, are not on too strong basis. The chances are that this kind of technology doesn't come available shortly and possibly it might take several decades.

In order for the distributed energy production to work, there would have to be a large integration of the electricity markets. A major part of a country could have cloudy weather or not enough wind to power the wind power plants for several weeks. In case that major part of the energy would be produced using the solar and wind power technologies, the grid would have to be connected to other countries in such a way that they could provide the energy needed during the low-production seasons. Other option is that an extremely efficient way to store energy will be invented.

Relying this much on the energy distribution of other countries would be a significant risk for national security. It would also be very difficult and expensive to build this kind of electricity distribution network. Therefore it doesn't seem likely to happen in the near future. Other part of the problem is the huge costs that building this kind of system has.

The energy production is facing a dramatic shift towards renewable energy sources. The distributed energy production possibilities are under discussion and we will hear a lot from this topic in the future. Anyhow it doesn't sound like a topic in which the blockchain will have its next success story.

9.2.2 Open electricity markets

GOS also points out another energy-related use case, the energy contracts ledger. In their vision is an open market place, where the consumers and producers would be placing buy and sell bids on electrical energy. They say that a consumer intending to change its energy supplier faces several challenges; first they need to close the current contract, next step is to open a new contract with the new supplier, and after this they have to revisit the contractual conditions of all complementary energy services provided by third parties. The administrative complexity of an energy supplier change is huge barrier for competitive energy market.

Instead, GOS says that the energy contracts could be stored to a distributed ledger. All market participants would have the access to this information, and they could easily update the ledger in case that the consumer wants to change its supplier. This would significantly simplify the process and allow the consumers in the future to change their energy suppliers by just a few clicks on a computer or mobile device.

This system would be powered by the distributed ledger technology. The idea of totally open markets, where each household has equal rights to access the energy sales as the big producers of energy seems pretty absurd. Electricity can't be compared to stock markets. In stock markets a low sales volume during a day doesn't affect anything but the rewards of the stock exchange company. In electricity markets the situation is completely different. In case there´s no sales bids, it will dramatically affect the functioning of the whole country immediately. Lack of energy will cause the distribution network to fall.

In case of a totally open markets, as visioned by GOS, all the producers should have the same rights and therefore same liabilities. The micro-producers, which are just small households, cannot be held in charge of maintaining the stability of the power supply system. If only big producers would be held in charge for this, they would face costs that the micro-producers wouldn´t have to care about. That would be anything but open market with all parties having the equal opportunities. In an open market, no one would be in charge of the system, which in case of electrical energy production wouldn´t work. Among others there's the issue of scalability. Morgan Stanley (2016) pointed out that maintaining a distributed ledger and encrypting the transactions there isn't free of charge. Therefore it should be, at least in the beginning, be applied to applications where the amount of transactions to be encrypted are limited. Monitoring the energy production and consumption of billions of households doesn't fit into these frames.

In energy contracts ledger GOS uses eliminating the administrative complexity that a consumer faces when changing its energy provider as one justification for the distributed ledger technology. It points out that due to new technology, in the future the customers could change their energy provider quickly using internet. It's probably true that the distributed ledger technology could reduce the costs and make the process quicker. On the other hand, the same benefits could be enabled for the customer using existing technology. This is the case for example in Finland, where the consumer has been able to change the energy provider by a few clicks in internet for several years now. As said, the new technology would probably make the process quicker and offer cost savings for the companies, but it's unclear whether these benefits would justify the investments needed for the system update.

These examples illustrate the lack of criticism that so many players in the blockchain/distributed ledger scene seem to have. One shouldn't be too confiding in all the justifications stated to be, as there seems to be a lot of overpositivism in the field. The new technology truly has great opportunities to make several markets more efficient and could totally revolutionize some of them, but there is no sense in trying to apply it everywhere.

It's good to have ambitious visions also in energy production to lead the development of the industry, but as it seems clear that these changes will take several decades to be carried out, it's pure stupidity to drag the blockchain technology into this kind of speculations. The focus of developing the blockchain/distributed ledger technology should be on projects that have the potential to be successfully implied in the near future. The hype around the new technology and visions of how the blockchain will revolutionize everything might drag attention away from the use cases where it actually might prove to be extremely useful in a very short timespan.

10. Conclusions

There seems to be a consensus that the blockchain/distributed ledger technology has a great potential and it could, at least in some parts of the markets, revolutionize the functioning of financial world. The benefits include increased efficiency, cost savings, security and opportunities for more inclusive monitoring of the markets for authorities. The smart contracts can provide automated solutions where the need of having trust between the counterparties is eliminated, which means decreased counterparty and credit risks and enables new kind of services in many different fields.

Even though all players seem to be positive on the potential of blockchains, there´s a significant difference in the views of traditional financial institutions and the fintech companies. The banking sector is unanimous on the view that there´s no use for Bitcoin or other permissionless blockchains in the financial markets. Instead, they see that the right way to implement the new technology is to build private blockchains, where all the participants are identified. The R3 consortium formed by the biggest banks of the world is perhaps the most visible example of an attempt to create an interbank blockchain.

The fintech scene is an area with numerous different companies, and of course among them there's a variety of stances on the future of blockchains. There are also several different kind of technical implementations of the technology. Anyhow, it seems that in this field the players are generally more positive on blockchain/distributed ledger technology and especially on Bitcoin than in the banking sector. There´s not too much attention being paid on the legal issues or the disadvantages of the permissionless blockchains. Instead the attitude seems to be that the technology and legislation will develop and these issues will be successfully handled in the future. The startup scene seems to be concentrated on solutions based on Bitcoin and other permissionless blockchains, which makes the implementation of the technology a rather fast and economical process.

At the moment banks' approach stating that only the permissioned blockchains have a chance to succeed seems to be justified especially due to the fact that they are easier to integrate to the existing systems. The legal issues, especially handling the challenges of KYC and AML speak in favor of permissioned systems. The financial institutions point out that at least in the beginning blockchain should be applied to only certain markets. These are sectors where the volumes are lower and the amount of parties involved is limited. **Banks' view is that the technology works best in sectors where the amount of trust between parties is low, there are unnecessary intermediaries, cross-border payments or other barriers for efficiency. Trade finance, derivatives markets and post-trade settlement** are examples of sectors that banks seem to have most attention on at the moment.

Fintech companies, on their half, seem to develop blockchain applications for all kind of market segments. They have a significantly different stance than banks, it´s easy to get an impression that **many of these players are positive that blockchain could revolutionize all kinds of markets.** This has led to a situation where there might be too much hype on distributed ledgers and blockchains. It's important for the banks to have a focus on what are the most promising use cases where the new technology could provide cost savings and increased efficiency already in the short-term. It's clear that they can't spend their resources on projects that aren't profitable in a time span of around 3-5 years.

Banks have realized that digitalization and developing blockchain technology might pose a threat to the whole traditional banking industry. The fintech companies might be able to drag more profit pools towards themselves. In the most dramatic scenarios the whole existence of banks, at least in the form we today know them, is under discussion. The qualities of blockchain technology could eliminate the need for trusted central parties in making transactions and holding securities.

It has been seen in the past that dominant players have lost their positition to new, agile entrants. This has happened especially during digitalization. It has already happened in some segments of banking business, e.g. in loans and payment services. If banks fail to take this phenomenon seriously and don´t develop unprejudiced solutions, the same might happen also in financial markets. Blockchain and distributed ledger might be a game changer in this sector. If the technology keeps developing at a high pace, there might in future be applications one can't even think of today.

Anyhow, the banking sector seems to have the view that the traditional financial institutions have a competitive edge in implementing blockchain/distributed ledger technology to financial markets. There are rational arguments to promote this view. The banks have a major role in the functioning of societies and their settled relationships with clients and regulators give them a good position to develop and implement blockchain technology.

On the other hand the most revolutionizing solutions often come from environments where the players have ambitious aims, and therefore the banking sector should keep a close eye on what the fintech companies are doing. Cooperation with smaller players is important and the banks have already started to acquire promising companies as there's lots of expertize in this sector. This is a sign that banks have admitted that there might be superior solutions coming from the fintech sector and that banks themselves aren't the greatest experts when it comes to blockchain technology.

On the contrary, banks have advanced knowledge on how the financial markets function, and therefore by acquiring these fintech companies they have a fair chance to

succeed in creating dominant financial platforms. The fact that banks are very well positioned in the societies and have the funds needed to acquire the startups is the main reason explaining their competitive edge. **If the banks keep doing smart buyouts, and utilize the expert workforce they gain, it's easy to see them succeed in creating blockchain-based platforms that become a standard in many financial markets. The banking industry will become more efficient and the banks can create new profit pools from the innovations enabled by the blockchain technology**. This of course requires cooperation within the banking industry, but the industry has awakened to the need of collaboration and have formed several groups to create interbank solutions.

In case that the banks don't take the threat of new entrants seriously, or fail in their attempts on creating standard solutions for banking industry, it seems likely that they will lose some part of their business. At the moment the threat seems to biggest in the payments sector, as the blockchain technology offers a way to create lightweight payment platforms in a way never seen before. The technology is evolving at a high pace, and for example the issuance of central bank –issued virtual currency might facilitate the diffusion of solutions that at the moment seem to be far away. A central bank issued cryptocurrency would especially facilitate the introduction of new solutions provided by small fintech companies, as the issues related with trust on these smaller players would widely be eliminated.

Some of the biggest hurdles in implementing the new technology are the legal and governance issues. The lack of jurisdiction complicates the development of new solutions as it's unclear whether they can be applied to the legal frames or not. The regulators' side has, at least to some extent, taken notice on the blockchain technology and therefore there might be more clarity to these issues sooner than anticipated. It seems safe to say that at least the regulators don't have a negative stance on the new technology. As long as the stability, security, and functioning of the markets is secured, the regulators probably won't be preventing the diffusion of blockchains. Ensuring the controllability and possibility to supervise the markets is crucial.

There are lots of things happening in the blockchain sector, and the traditional financial institutions have invested significant amounts on research and developing their systems. It remains to be seen whether the blockchains and distributed ledger will inspire totally new kind of financial solutions, or rather have a complementary role in the existing systems. It seems, anyhow, to be safe to say that we will hear lots of blockchains in the future. The development of the new technology is just taking its first steps. Due to its high potential, we could see it become a success story much quicker than anticipated.

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